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Addendum to Data Compilation Task Report for the Source Investigation of the 300-FF-1 Operable Unit Phase 1 Remedial Investigations

J. S. Young
J. S. Fruchter

January 1991

Prepared for the U.S. Department of Energy
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Environmental Management Operations
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REPORT FOR THE SOURCE INVESTIGATION
OF THE 300-FF-1 OPERABLE UNIT PHASE 1
REMEDIAL INVESTIGATIONS

J. S. Young
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Environmental Management Operations
Pacific Northwest Laboratory
Richland, Washington 99352

SUMMARY

* In 1989 and 1990, Pacific Northwest Laboratory conducted additional investigations into fuels fabrication operations and waste disposal sites and practices associated with the 300-FF-1 Operable Unit in the 300 Area on the U.S. Department of Energy's Hanford Site. The project was a continuation of work reported in Young et al. (1990).

The purpose of the study was to obtain information on undesignated waste sites, process chemicals, and waste disposal practices associated with the operable unit. Methods employed included interviews with present and former operations personnel; inspection of old reports, drawings, and aerial photographs; and site visits.

Additional details of the fuels fabrication process were obtained, resulting in the addition of a number of new chemicals to the list of those known to have been disposed to the process ponds and trenches. The photographs revealed the location of several previously unreported waste sites, including an undesignated burn pit and several burial trenches. Additional information concerning the contents and boundaries of the burial grounds was also obtained. Finally, new information on unplanned releases from the chemical storage and waste acid treatment system tanks was obtained.

A fairly complete coverage of photographs and reports was provided over the time period during which the fuels fabrication facility operated. Therefore, it seems likely that a majority of the facilities and types of wastes have been documented and that little additional information on the source term for the operable unit will be available until remediation commences. It is recommended that, as the next step in the remediation process, a geophysical survey be performed on both designated and undesignated waste sites.

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1.0 INTRODUCTION

The purpose of this report is to expand on facility information and waste characterization in the 300-FF-1 Operable Unit beyond that presented in the work plan (DOE 1990a) and Young et al. (1990). This has been done in part by careful examination of aerial photographs of the 300 Area dating from approximately 1944 to the present. The photographs show details indicating installation, use, and sometimes the deactivation of waste facilities. They also reveal several waste sites that were either unknown or largely forgotten. Because the photographs include areas outside 300-FF-1, some details of waste sites and sources are described for other 300 Area operable units. In addition to the photographs, documents were reviewed, and former or long-time employees who had first-hand knowledge of the facilities and operations were interviewed.

The waste streams in the 300-FF-1 Operable Unit were largely from the fabrication of uranium fuels for the production of plutonium and from associated operations. This report begins with an overview of the early history of fuels fabrication and then describes the processes for making uranium fuels. It was these processes that were a source of much of the waste. The report then discusses the various 300 Area waste streams, their origins, constituents, routes, and fates. The photographs, arranged in chronological order in Appendix A, are not referred to sequentially in the text. Descriptions of buildings and facilities that contributed to the waste streams are in Appendix B. Appendix C contains Plates 1 and 2 showing waste sites in the 300-FF-1 Operable Unit.

1.1 EARLY HISTORY

In February 1943, 625 miles² of remote, semiarid shrub steppe near the small town of Hanford, Washington, was chosen by the War Department as the site for the manufacture of plutonium for the Manhattan Project of World War II--the construction of the first atomic bombs. The Hanford Site, as it became known, was soon divided into three major operational areas (100, 200, 300) for the production of this new element. The 100 Areas, located in the northern portion of the Hanford Site along the shore of the Columbia River (Figure 1), contained

100
Area

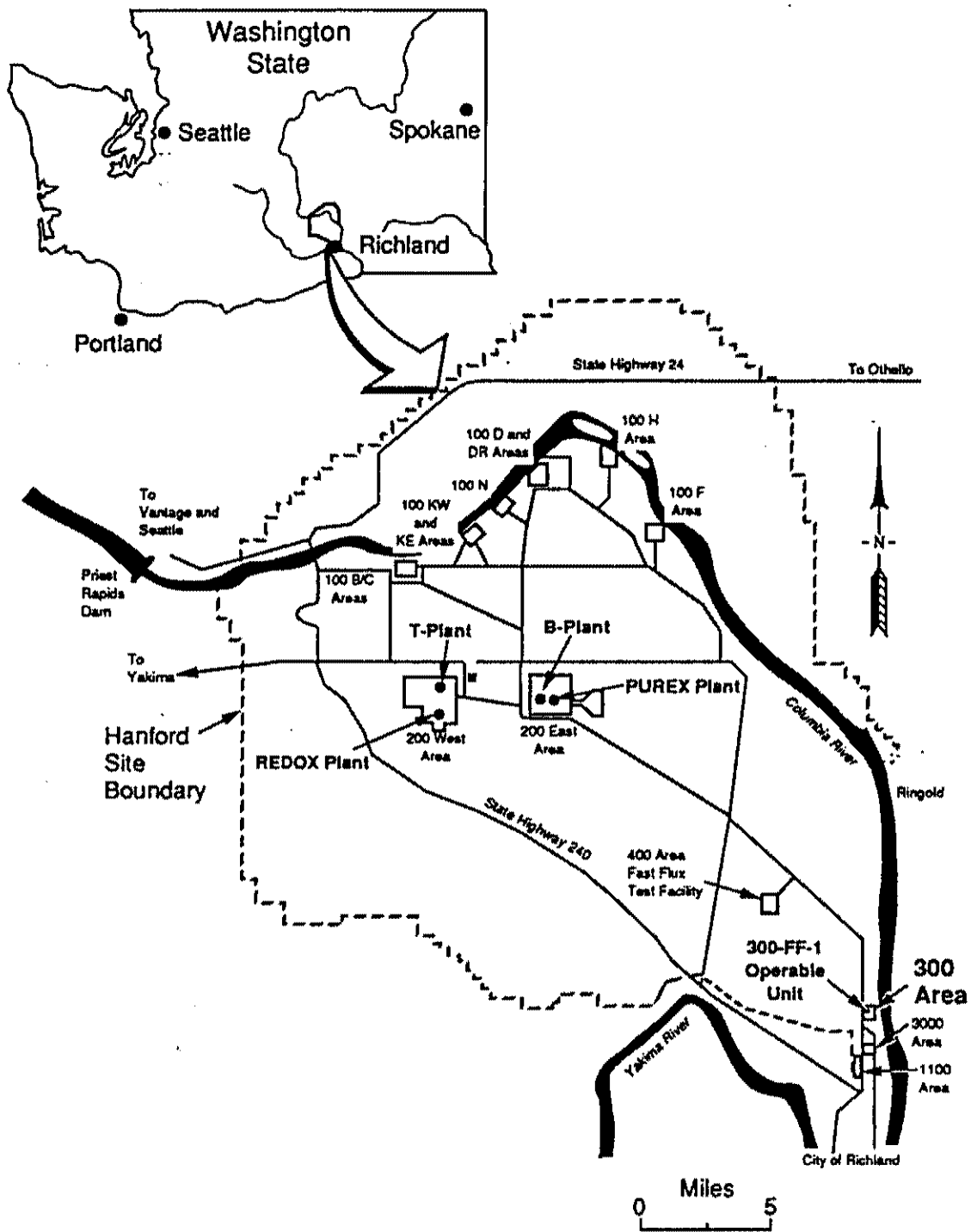


FIGURE 1. The Hanford Site

reactors for making plutonium. The 200 Areas, 6 to 11 miles south of the 100 ²⁰⁰ Areas, included facilities for separating plutonium from the neutron-irradiated reactor fuel. The 300 Area, near the town of Richland, accommodated the resources necessary to fabricate uranium fuel for the reactors ³⁰⁰ and test materials related to plutonium production processes.

During the war, three graphite-moderated reactors (B, D, and F) were built in the 100 Areas. In these reactors, purified, aluminum-encased (clad or canned) natural uranium fuel cores were bombarded with neutrons from the nuclear chain reaction. The uranium-238 in the cores captured some of these neutrons, transforming a minute portion of the uranium into plutonium-239. Just after the war, five more single-pass production reactors were built (C, DR, H, KW, KE), which also used aluminum-clad fuel. The N-Reactor, completed in 1961, used enriched uranium fuel clad with Zircaloy-2^(a), fabricated by a coextrusion process that bonded the uranium core to the cladding in one operation.

The irradiated fuel was removed from the reactors and transported to the 200 Areas, to the T-Plant or B-Plant, where it was dissolved and chemically treated to separate and isolate the plutonium from the uranium and the highly radioactive fission products resulting from the reactor operations. Initially, a bismuth phosphate process was used for separations. The final product, a viscous solution of plutonium nitrate, was shipped to Los Alamos where it was refined for weapons.

In 1951 the REDuction OXidation (REDOX) process succeeded the bismuth phosphate process when the REDOX Plant was built in the 200-West Area. Then in 1956, the Plutonium URanium EXtraction (PUREX) Plant began operating, taking over fuels processing operations from the REDOX Plant. At this facility, uranium, plutonium, and neptunium were separated from the irradiated fuel by decladding and dissolving the uranium metal, and subjecting it to solvent extraction and ion exchange.

(a) Zircaloy-2 is composed of zirconium with 1.2-1.7% tin, 0.07-0.2% iron, 0.05-0.15% chromium, and 0.03-0.08% nickel.

The manufacture of the fuel rods that went into the reactors took place in the 300 Area (Figures 1 and 2). Construction of the 300 Area fuels fabrication facility began in 1943. By May 1944, the canning equipment was installed in the 313 Fuels Manufacturing Building (300 Area buildings are listed in Appendix B), and production of fuel elements began the following month (DeNeal 1965). Until 1949, only natural uranium fuel was manufactured. After 1949, fuel elements enriched to various degrees were also fabricated. The following section gives the details of the fuels fabrication processes.

[illegible]

2.0 FUELS FABRICATION PROCESSES

The first plutonium production reactors were cooled with a single pass of water that would flow around the uranium fuel elements and carry away the heat generated by fission. Uranium in direct contact with water is highly reactive, so the uranium cores had to be covered and sealed with a heat conductive substance that would absorb few neutrons. For these single-pass production reactors, a thin aluminum jacket was chosen to clad the uranium for protection from the water. This cladding had to fit tightly with no air spaces. The processes of manufacturing aluminum-clad fuel, as described in this report, were gathered from several sources, including Weakley (1958) and Sanger (1989).

From early 1944 to the 1953 startup of the Feed Materials Production Center in Fernald, Ohio, the bare uranium cores (4 to 8 inches long) were fabricated mainly in the 314 Building as follows:

1. Uranium tetrafluoride was mixed with calcium or magnesium, heated, and reduced to a uranium metal regulus, often called a derby because it was shaped like a derby hat.
2. Derbies and salvageable uranium scrap from the fabricating operations were loaded into a graphite crucible and remelted into ingots. rods 314
3. The ingots were machined to size. Uranium fines were burned.
4. The ingots were extruded or rolled into rods either at Hanford or offsite.
5. The rods were straightened in the 314 Building and machined into cores in the 313 Building. Uranium chips were burned or encapsulated in concrete. machining 313

The aluminum canning process used from the 1940s until March 1954 was the triple dip process and was conducted in the 313 Building. It consisted of the following steps:

1. The uranium cores were preheated in a bath of molten, high-tin bronze covered with a layer of flux. bath/dip
2. The cores were quenched in a molten tin bath, which also removed excess bronze from the core surfaces.

3. The cores were centrifuged to remove excess tin.
4. The last of the tin was removed by dipping the cores in an aluminum-silicon bath.
5. The cores and aluminum cans and caps were then assembled in a molten aluminum-silicon bath.
6. The canned assemblies were quenched in water.

lead dip From March 1954 to late 1971, the canning operation was changed to the more economical lead dip process which replaced the first four steps of the triple dip process with the following two steps:

1. The uranium cores were preheated in the lead layer of a molten duplex bath consisting of an upper aluminum-silicon layer and a lower lead layer.
2. The cores were then agitated in the aluminum-silicon layer of the duplex bath to remove excess lead.

testing After the fuel elements were clad, the end caps were machined and welded to the can. Each assembly was cleaned with trichlorethylene and nitric acid, steam autoclaved to detect any perforations in the cladding, and X-rayed for weld voids. Until ultrasonic testers were developed in the early 1950s, braze voids and unbonded areas were located by spraying an acenaphthene/carbon tetrachloride solution on the fuel element. The carbon tetrachloride evaporated leaving a frosty coating of acenaphthene. When passed through an induction coil, the coating melted into a shiny spot at a void or unbonded area.

I+E In 1955 the fuel element design was changed from a solid rod shape to a tube shape called I & E (Internally and Externally cooled) elements.

N-Reactor The fuel elements in the N-Reactor were arranged in a tube-within-a-tube configuration that provided three channels for flow of the water coolant around the fuel: 1) around the outer tube, 2) between the two fuel tubes, and 3) through the hole in the inner tube. The inner fuel tube was enriched to 0.95% uranium-235. The outer tube was enriched to either 0.95% or 1.25% uranium-235. Each tube was clad inside and out with Zircaloy-2. Fabrication was conducted in the 333 Building. The following operations produced the fuel elements (UNI 1979; Ballinger and Hall 1989):

333

1. **Component cleaning** - Uranium cores, Zircaloy-2 cladding shells, and copper-silicon components were cleaned by vapor degreasing in trichloroethylene, perchlorethylene, or 1,1,1-trichloroethane; etching and cleaning in acid; rinsing in process and deionized water; and warm-air drying. Etching and cleaning acids were nitric, nitric-hydrofluoric, and chromic-nitric-sulfuric acids.
2. **Billet assembly and preheating** - The uranium core and components were assembled into billets. The uranium core was a thick tube, and an inner Zircaloy-2 shell was placed inside the core, an outer shell outside the core. A copper-silicon jacket was placed outside the Zircaloy-2, and end plates were fusion welded, helium-leak tested, and sealed. Billet assemblies were then preheated.
3. **Extrusion** - The preheated billet assemblies were extruded to the tubular fuel configuration in a high-pressure press. The copper-silicon jacket surrounding the billet served the dual purpose of preventing oxidation of the underlying metallic surfaces and acting as a lubricant during extrusion. Graphite was also used as a lubricant.
4. **Element shaping and cleaning** - The extruded fuel tubes were cut underwater (to prevent the fines from igniting) into fuel element lengths by abrasive cutoff saws. Both ends of the fuel pieces were then machined to provide recesses for the Zircaloy-2 end caps. The remaining copper-silicon jacket was removed by hot nitric acid, the elements were water rinsed, and the thin layer of uranium left on the walls of the fuel ends was removed by chemical milling in hot nitric-sulfuric acid. The stripped and chemically milled pieces were cleaned before installation of the end caps by etching in nitric-hydrofluoric acid and a nitric acid-aluminum nitrate solution.
5. **End cap** - The recessed ends of the fuel pieces were sealed with Zircaloy-2 end caps that were vacuum brazed to the cladding with a 5% beryllium/Zircaloy-2 braze alloy. The sealed fuel elements were then heat treated in high-temperature salt baths to produce random orientation of the uranium grain structure and to ensure dimensional stability of the fuel during irradiation. The ends of the heat-treated fuel elements were faced off on a lathe, and the elements were vapor degreased and abrasive blasted with aluminum oxide grit to remove any scale or residual salt. There was another acid cleaning and a final fusion welding of the end cap and spot welding of support hardware. *Importance of random testing*
6. **Testing** - The fuel elements were steam autoclaved to detect any perforations in the cladding or end cap. Nondestructive testing *@ same time* employed ultrasonics, eddy currents, and autoradiography to detect unbonded areas, thin cladding, or uranium in the weld area.

Other production activities related to reactor fuel operations for the eight single-pass reactors included:

- canning lead-cadmium poison elements (1943 to mid 1950s)
- canning bismuth-lead alloy elements for polonium-210 production (1943 to 1950s)
- canning lithium-aluminum alloy target elements for tritium production (1947 to 1952)
- canning thorium powder and target elements for uranium-233 production (1963 to 1970)
- canning uranium-aluminum alloy driver elements for tritium and uranium-233 production (1947 to 1952 and 1963 to 1970)
- anodizing used aluminum reactor spacers for reuse (late 1950s to late 1971)
- developing the Hot Die Size process of canning nickel-plated uranium cores (mid 1960s to 1971).

The fuels fabrication facilities for N-Reactor were conducted mainly in Buildings 333 and 334 (see Appendix B). Activities specific to the N-Reactor included:

- canning lithium-aluminate target elements for tritium production (1965 to 1967)
- passivating (applying a chemical coating to reduce oxidation) steel reactor spacers (1973 to 1982)
- calcinating pyrophoric uranium and Zircaloy-2 chips and fines to oxide for safe shipment (1962 to 1971 and 1983 to 1988)
- concreting (mixing with concrete) these same kind of pyrophoric chips and fines into 7.5-gallon billets for safe shipment (1971 to 1982)
- fabricating copper-silicon preshapes from remelted scrap copper-silicon (1968 to 1987).

3.0 300 AREA WASTE STREAMS

Wastes generated in the 300 Area from fuels fabrication processes, laboratory operations, and other activities are categorized on the basis of ^①source of the waste, ^②whether it is liquid or solid, ^③its level of radioactivity, and ^④how the waste was ultimately disposed of. Process wastes are liquid waste products associated with fuels fabrication and some laboratory activities that are discharged to the Process Sewer. Process wastes generally have low levels of radioactivity. Retention process wastes, mainly from laboratories, are potentially more radioactive than process wastes. These liquids are retained in a reservoir where the radioactivity is measured. If the radioactivity is above a certain level, the retained liquids become radioactive wastes and are transported to the 200 Areas for disposal. If the radioactivity is below that level, they are process wastes. Sanitary waste is waste water from lavatories and kitchens that enters the Sanitary Sewer. The 300 Area sewer systems are reviewed in Young et al. (1990). Solid wastes, radioactive and nonradioactive, were either burned or buried at numerous sites in the 300 Area.

process waste/ Sewer
retention process waste
Sanitary waste

The sources, handling, and fate of these wastes evolved over the history of the 300 Area, and much of what follows in this report is an account of that evolution.

3.1 PROCESS WASTES

Liquid waste streams from the fuels fabrication process were directed through the Process Sewer to either of two large, open, percolation ponds. The South Process Pond (316-1), which eventually covered 353,000 ft², was placed into service in 1943. It originally received cooling water and low-level liquid wastes from the 313, 314, 3706, and 321 Buildings; small quantities of organic wastes containing uranium; water from the fuels processing floor drains; and by the end of the first decade of fuels fabrication, aqueous wastes containing unirradiated uranium from laboratories. Most of the alpha activity in the pond was from uranium, although small amounts of plutonium were occasionally found in the principal waste lines to the pond (Paas 1955). Liquid wastes originally flowed into the pond from a drainline

composed of bell and spigot vitreous clay pipe (the Process Sewer) by way of a trench on the pond's south side. Photograph A.1 shows the pathway of the process sewer, the southside trench, and the pond before complete excavation.

Prior to August 1945, the pond was diked on the north, south, and west sides to about 3 ft above the water level. The east side of the pond was not diked because it was believed that the ground level was of sufficient height and the flow of water into the pond was reduced enough to prevent overflow. The pond did overflow on August 8, 1945. A considerable area outside the pond was covered with about 1 inch of water. A small stream reached a road leading to the Columbia River but seeped into the sand before reaching the river's edge. Low spots on the east side were then temporarily diked with a bulldozer (Appendix D). A short time later the entire eastern edge of the pond was diked permanently.

313
1945 -
slug recovery

This overflow was probably the first indication of reduced infiltration through the pond bottom caused by the accumulation of impermeable precipitates from the dumping of sodium aluminate (Appendix D). Sodium aluminate was a waste product derived from removing the aluminum cladding of rejected fuel assemblies to recover the encapsulated uranium. This decladding process took place in the 313 Building (uranium recovery facility), where the aluminum was dissolved with 15% sodium hydroxide to form sodium aluminate. The sodium aluminate was collected in dumpster truck tanks, and two or three times a week the tanks were hauled to one or the other pond and drained down the dike. This heavy waste, with a specific gravity around 1.5, ran underneath the water in the pond where it gradually became diluted and formed a gelatinous aluminum hydroxide precipitate that plugged the pond bottom, preventing liquid percolation into the soil (Clukey 1954).

A dike of the South Process Pond failed October 25, 1948, releasing an estimated 14.5 million gallons of uranium-contaminated water down a natural channel into the river. A section of the river bank washed out, leaving a scar that is visible in Photograph A.31. Singlevich and Paas (1948) described in the original report of the dike failure how the northwest corner of the pond gave way; current opinion, however, is that it was the northeast corner that failed. The rupture was attributed in part to muskrat

burrows weakening the earth berm (Herde 1948), but the sealing of the pond bottom by sodium aluminate had also caused the water level to rise 4 ft above normal, increasing the pressure on the bank and causing the breakthrough. The total uranium entering the river was roughly estimated to be 12 to 61 lb. The dike was repaired, and a new pond, the North Process Pond, was put into service November 14, 1948 (Clukey 1954). *N. Process Pond*

The North Process Pond (316-2), covering 434,000 ft², was constructed in late 1948 as a result of the 1948 dike failure and because the bottom of the South Process Pond became impervious. The Process Sewer Line, again constructed of clay pipe, was branched northward to the southwest corner of the north pond. Its pathway can be seen in Photograph A.15. Flow to the ponds was controlled by diversion boxes. Brown and Ruppert (1950) reported that "significant amounts" of plutonium were occasionally found in these waste lines. The bell and spigot joints were leaky, so it is likely that contaminants entered the underlying soil. In 1953 the inlet to the South Process Pond was moved from the southwest corner to the northwest corner to accommodate a new process sewer that included waste from the expanded 313 Building and the 306 Building.

The ponds were dredged numerous times to remove the impervious bottom crust and restore percolation. The South Process Pond was dredged in 1948, 1949, and the summer of 1953. Both ponds were dredged during the fall of 1952, and the North Process Pond was dredged sometime in 1953 and July 1954 (Clukey 1954; Paas 1955). Photograph A.17 shows the North Process Pond being dredged by drag line during May 1956. Later excavations in the late 1950s and 1960s were made by an earthmover. The sediments from the dredging were deposited on the surrounding dikes and on the scrapings disposal area south of the pond. Over the 10-year period before 1954, Clukey (1954) estimated that an average of 5800 gallons per month of sodium aluminate, containing an average 50 lb of uranium was disposed of in the ponds, which amounted to about 6000 lb of uranium. By 1956 sodium aluminate was no longer trucked to the ponds, but was included in the waste stream from the 313 Building. *dredging*

In Photograph A.6 it appears that by 1951 the south side of the South Process Pond was either rediked or further excavated to provide a separate

holding trench for coal fly ash. An 8-inch pipeline from the 384 Building (Power House) to the ash trench was installed possibly at this time or shortly after. The pipeline and the ash trench appear in a drawing by Clukey (1954).

Both ponds received portions of cooling water and low-level liquid waste from the 321 Building, aqueous waste containing unirradiated uranium from the Works Laboratories (Buildings 325, 326, 327, and 329), and water from floor drains in the fuels processing area and the 3706 Building.

The 321 Building operated from 1944 to 1954 as a pilot plant for the development of the REDOX and PUREX processes. Nitric acid solutions containing uranyl nitrate and small amounts of thorium nitrate (to simulate plutonium) were routinely processed here, and large amounts of uranium were discharged into the process ponds. Some organics may have also entered the ponds, although starting in 1948 these organic wastes were transferred to the 321 Crib in the 300 North Burial Ground.

Waste from the 3706 Building entering the ponds before 1953 probably contributed most of the approximately 55 mCi of plutonium and 8 Ci of beta-emitting radioisotopes observed in the Process Sewer samples. About 900 lb of uranium was disposed of during 3706 operations. When the 325, 326, 327, and 329 Buildings were completed and occupied in early 1954, most of the operations from the 3706 Building were moved to these new facilities (mainly the 325 Building). The Metals Preparations Laboratories, which analyzed only unirradiated uranium, remained in 3706 for 2 more years (Clukey 1954; Paas 1955).

Organic solutions from 3706 were collected in bottles and poured periodically into a stainless steel pipe on the north side of the South Process Pond. About 20 lb of uranium a year went to the pond from this source (Clukey 1954).

Between 1948 and 1954, Clukey (1954) estimated that 26,645 lb of uranium had been discharged to the ponds, including the 6000 lb from the sodium aluminate and 19,145 lb of mostly ^{235}U -depleted uranium from the largest contributor, the 321 Building. From the beginning of August 1954 through October 1956, an additional 13,700 lb of uranium went to the ponds, bringing

the total to 40,300 lb (Heid 1956). Records for succeeding years are sketchy; however, from Wells (1968) 6500 lb were calculated to have been added in fiscal year 1967, and from Traxler and Wells (1968) another 2500 lb was discharged in fiscal year 1968. It is probable that at least 1000 lb per year was added in the years for which records were not found. N-Reactor Fuels Fabrication disposed of an additional 9980 lb from September 1961 to December 1974. The estimated total uranium discharged during the life of the ponds is over 74,000 lb. How much seeped into the Columbia River is unknown; however, the total discharge of uranium to the ponds can be compared with the amount of dissolved natural uranium that flows down the river each year.

Virtually all rocks and soils contain small amounts of natural uranium, some of which is soluble in water. Because the water in the Columbia River flows over and through large volumes of rocks and soils, it contains small concentrations of natural, dissolved uranium. During the years 1982-1987, the natural uranium concentration of the Columbia River at the Vernita Bridge (above the Hanford Reservation) averaged 1.0 parts per billion (ppb) (Jaquish and Mitchell 1988). During this period, Columbia River flow averaged 113,000 ft³ per second. This yields an average yearly flux of approximately 214,000 lb per year of natural uranium at Richland. Because of the relatively small number of measurements and the large variability of river flow from year to year, this should be taken as only an order of magnitude estimate.

As discussed previously, approximately 75,000 lb of uranium was disposed to the process ponds during their operation. Of some concern for remediation efforts is whether the uranium mostly sorbed or precipitated on the soils beneath the pond and is still present or whether it was relatively unretarded and so migrated directly into the Columbia River. Data pertinent to this question are presented in DUN (1967). Both pond inlet water and water from seeps near the ponds flowing into the river were measured during 6 weeks in 1967 while the ponds were still active. During this period, the pond inlet water averaged 0.45 ppm uranium, while the seeps averaged 0.36 ppm. Thus, it appears from these data that soluble uranium is largely unattenuated by the soils beneath the pond. When the seeps were measured again in 1983 by McCormack and Carlile (1984), the concentration averaged about 0.03 ppm, so

that apparently some of the uranium that was adsorbed is still bleeding out. However, Dennison et al. (1989) have identified particulate insoluble uranium on pond sediments.

Another interesting observation reported in DUN (1967) concerned hexavalent chromium migration. Apparently, chromium was not disposed of continuously, but rather at infrequent intervals. Elevated chromium levels were detected in the seep water approximately 7 days after the chromium was discharged to the pond. Thus, an idea of travel times for relatively unretarded species such as hexavalent chromium in the pond system can be deduced from these data.

Inorganic and organic chemicals were also discharged to the North and South Process Ponds (See Tables 1 and 2 for lists of chemicals), including 532,000 lb of copper, more than the estimate in Young et al. (1990). According to R. B. Hall (personal communication), pH in the ponds ranged from 1.8 to 11.4; however, sodium hydroxide was added to prevent copper from leaching through the soil into the river. An accident in the 321 Building (date not known) resulted in the loss of some plutonium to the Process Sewer (Clukey 1954). After the mid-1950s, when research and development diversified, almost any chemical may have been discharged to the ponds in laboratory and

TABLE 1. Estimates of Chemical Ions Released to 300 Area Process Ponds from N Reactor Fuels Fabrication (Based on DOE 1990b and average N Reactor Fuels Process Sewer data from 1978-1986)

	<u>Copper</u>	<u>Flouride</u>	<u>Nitrate</u>	<u>Sulfate</u>	<u>Chromium</u>	<u>Manganese</u>
Waste Acids (1b)	526,000	236,000	3,638,000	905,000	2,000	3,800
Rinse Water (1b)	6,000	22,000	905,000	-	-	-
Total to 300 Area Process Ponds (1b)	532,000	258,000	4,543,000	905,000	2,000	3,800

TABLE 2. Chemicals Routinely Used in the Various Fuels Fabrication Processes that Would have Entered the Process Ponds. Compiled from Weakley (1958), Loe (1967), and DOE (1990b).

*Acenaphthene	Aluminum hydroxide
*Aluminum metal particles	Aluminum nitrate
*Aluminum oxide	Ammonium bifluoride
*5% Beryllium/Zircaloy-2 alloy	*Boric acid
*Bronze (copper-tin) particles	*Calcium fluoride
Carbon tetrachloride	Chromic acid
Copper oxides	Copper and copper-silicon particles
*Cupric nitrate	*Dibasic ammonium citrate
*1,3-Diethyl-2-thiourea	*Ethylenediaminetetraacetic acid
Fluosilicic acid	Fluxes (barium, potassium and sodium chlorides)
*Graphite particles	Hydrochloric acid
*Hydraulic oils (some with PCBs)	*Hydrogen fluorozirconate
Hydrofluoric acid	*Lead oxides
Lead metal particles	*Lithium carbonate
*Lithium aluminate	*Magnesium fluoride
Lubricating oils	*Manganese nitrate
*Magnesium oxide	*Methanol
Masonry cement	Nickel sulfate
Nickel chloride	Oxalic acid
Nitric acid	Potassium carbonate
Phosphoric acid	Potassium nitrate
Potassium chloride	Silicon dioxide
*Potassium permanganate	Sodium aluminate
*Silicon metal particles	Sodium carbonate
*Sodium bisulfate	Sodium dichromate
*Sodium chloride	Sodium gluconate
*Sodium diuranate	Sodium metasilicate
Sodium hydroxide	Sodium nitrite
Sodium nitrate	Sodium silicofluoride
Sodium pyrophosphate	Tetrachloroethylene
Sulfuric acid	*Tin metal particles
*Thorium dioxide	Trichloroethylene
*Tin oxides	*Uranium tetrafluoride
Uranium oxides	Water soluble oils
Uranyl nitrate	Zirconium oxide
*Zircaloy-2 particles	
X-ray film developer chemicals (not included above):	
*Acetic acid	Aluminum sulfate
Ammonium thiosulfate	Diethylene glycol
Gluconic acid	*Glutaraldehyde
*Hydroquinone	*1-Phenyl-3-pyrazolidone
Potassium dichromate	Potassium hydroxide
Silver ions	Sodium sulfate
*Sulfamic acid	
Acetone	
*Rhodamine B	
Lithium nitrate	

* Compounds or materials not reported in DOE (1990a), Young et al. (1990), or Stenner et al. (1988).

pilot plant quantities, including most used in plating development, Fast Flux Test Facility (FFTF) fuel development, photography labs, metallurgical labs, and corrosion labs.

Normally, activation products would not be expected in fuels fabrication wastes. However, DUN (1967) reports the presence of zinc-65, cobalt-60, iron-59, and chromium-51 in the wastes discharged from the fuel fabrication facilities into the process sewer. The presence of these radionuclides is because the facilities were also used for reanodizing aluminum spacers from the reactors. The activation products were contained as contaminants on the spacers and were solubilized during the reanodizing process. Typical radionuclide concentrations in caustic anodizing wastes reported in DUN (1967) are shown in Table 3. All have half-lives of 5 years or less.

3.2 RETENTION PROCESS AND RADIOACTIVE LIQUID WASTES

As early as 1950 it was recognized that the North and South Process Ponds were "an inferior and potentially hazardous temporary expedient, ... justified only (if at all) by the relatively low activity of all components except uranium" (Brown and Ruppert 1950). Construction of the Works Laboratories (325, 326, 327, and 329 Buildings) began in 1951. To accommodate this expansion without putting more pressure on the process ponds, the 307 Retention Basins, the two 307 Trenches (316-3), and the 340 Loading Facility were built along with two separate pipelines, the Retention Process Sewer and the Radioactive Liquid Waste Sewer, for disposal of potentially contaminated and radioactive waste liquids from the new laboratories.

The Retention Process Sewer line and the 307 system were installed for potentially contaminated "retention" liquids from the sinks, sumps, and drains of the laboratories. Retention wastes were collected in the 307 Retention Basins, which consisted of four 25,000-gallon, open, concrete receiving basins coupled into 50,000-gallon pairs used alternately as short-term holding facilities. These basins are still in use today. Here the wastes were sampled, and if radioanalytical results were below prescribed limits, the wastes were drained to the 307 Trenches (located just inside the southern boundary of 300-FF-1) for seepage into the ground. If concentrations of radioisotopes exceeded the limits, the retention wastes were transferred to two 15,000-gallon crib waste collection tanks in the adjacent 340 Loading Facility, where they were trucked by tank-trailers to the

TABLE 3. Typical Radionuclide Concentrations in Caustic Anodizing Wastes Reported in DUN (1967)

<u>Isotope</u>	<u>Activity Level (μCi/ml)</u>
Zinc-65	0.19
Iron-59	0.03
Cobalt-60	0.02

216-SL Crib in the 200-West Area. Allowable activities discharged to the basins were originally 4 g/L of gross beta and 0.5 g/L for plutonium (Clukey 1954). Any acid wastes were neutralized with sodium hydroxide. The limit was later changed to an activity of 50,000 pCi/L.

The Radioactive Liquid Waste Sewer (RLWS), which collected radioactive liquids from the Works Laboratories, went directly to the 340 Loading Facility for trucking to the 200-West Area. The location of this retired RLWS and the buildings it served are discussed in Young et al. (1990).

Excavations for the two 307 Trenches, the lines leading to the trenches, and the 307 Retention Basins were begun in January 1952. By the end of February 1952, the 307 Trenches were dug, and forms were being built for pouring concrete for the basins and the 340 Loading Facility.

The newly constructed trenches and the forms for the pouring of the 307 Basins and 340 Loading Facility are clearly visible in the upper left corner of Photograph A.8. Photograph A.9 shows construction underway on the 307/340 Complex, including the 8-inch pipes on the south side of the basins that feed the trenches. Two access points to the pipes, possibly manholes, can be seen at the heads of trenches in the lower right of the photograph. These access points are also indicated on the as-built drawing M-3904, sheet 3 (September 1, 1971).

Photograph A.9 also shows a trench containing the RLWS. A portion of this single wall, stainless steel line can be seen near the center of the photograph, just below the railroad cars, as it angles north toward the 327 Building. The Retention Process Sewer was laid along side parts of the RLWS.

The new liquid waste systems were in use by 1953. During the last 6 months of 1953, an average of 16,000 gallons of crib waste were generated. This average increased to 38,000 gallons during 6 consecutive months of 1954 (Clukey 1954). By 1958 monthly volumes were 100,000 to 150,000 gallons (Haney 1960). The daily discharge to the 307 Trenches by the end of the 1950s was 125,000 gallons. Heid (1956) estimated that by the end of October 1956, 3.09 g of plutonium and 0.226 curies of beta emitters had been discharged to the 307 Trenches. Contents of the retention basins were sometimes released to the trenches without sampling. Haney (1960) estimates that 40% of the retention wastes were discharged in this manner.

The 307 trenches were taken out of service in 1963 (Photograph A.24), and retention waste below the discharge limits went to the process ponds until 1975 when the current Process Trenches (316-5) were constructed (Photograph A.29). The current Process Trenches are discussed in Young et al. (1990). The 307 Trenches were excavated, and most of the contaminated soil was taken to the 300 North Burial Ground. In 1965 they were backfilled with 10,000 yd³ of uranium-contaminated sediments from 316-1 and some coal flyash (ICF Northwest 1987).

In 1987 the east end of the 307 Trenches near the 3727 Building was used for testing a grout liquid waste solidification process. A 20- by 50- by 9-ft-deep section of the trenches was excavated, and in doing so contaminated material was encountered, probably backfill from the South Process Pond, with up to 378 pCi/g beta and 234 pCi/g alpha radiation (ICF Northwest 1987).

3.3 SEWAGE WASTES

Between 1943 and 1948, sewage waste was sent to a septic tank and the "tile field" (Photographs A.1, A.2, A.4), a leach field consisting of perforated bell and spigot vitreous clay pipe. Water in the tile field in Photograph A.1 indicates the facility had exceeded its capacity by the late 1940s. The septic tank collected solids from the sewage, and sodium hydroxide was occasionally used to liquify the sludge and send it to the tile field.

The tile field was replaced by the Sanitary Leach Trenches, two sub-parallel trenches that branch eastward in a narrow "V" pattern from a pair of septic tanks. These trenches are in use today. The southern trench was evidently dug during or prior to 1948 (Photograph A4). The north trench was constructed at the beginning of 1952. Both can be clearly seen in Photograph A.11 taken June 8, 1953. The lines leading to the septic tanks are 8-inch clay pipe that feed into a diversion box that can direct the sewage to one septic tank or the other. A second diversion box located behind the septic tanks directs the liquid overflow to one of the trenches. This liquid effluent is chlorinated. When the septic tanks are periodically cleaned, sludge is pumped to a nearby sludge pit (see as built drawing M-3904, Sheet 2, June 12, 1989).

3.4 ADDITIONAL LIQUID WASTE FACILITIES

Although not officially within the current boundaries of the 300-FF-1 Operable Unit, two tank farm complexes were an integral part of the liquid streams involved in the fuels fabrication process. These are the 311 Tank Farm and the 334 Tank Farm (see Figure 3). Both of these tank farms were used to store process chemicals, such as nitric acid, sulfuric acid, sodium hydroxide, perchlorethylene, trichloroethylene, and methanol. A pumping and mixing facility for these chemicals was located in the 303-F building (Figure 4). Numerous leaks of the chemicals from these tanks as well as from associated valves and piping have been documented (DOE 1990b). Most of the leaks went into the process sewer; however, some went to ground. The spills to ground are listed in Table 4. In particular, DOE (1990b) reports that the soil pH around the sodium hydroxide tanks remains so high that chemically resistant suits are recommended if any excavations are contemplated in the area.

313 -
chemical
Storage
200
2.0.0

Both the 311 and 334 Tank Farms were also part of the 300 Area Waste Acid Treatment System (WATS). Acid used in various etching and chemical milling processes was neutralized before being discharged to the Process Sewer. Wastes from other 300 Area operations were also treated in the WATS system. Solids resulting from the treatment operations were removed and

WATS

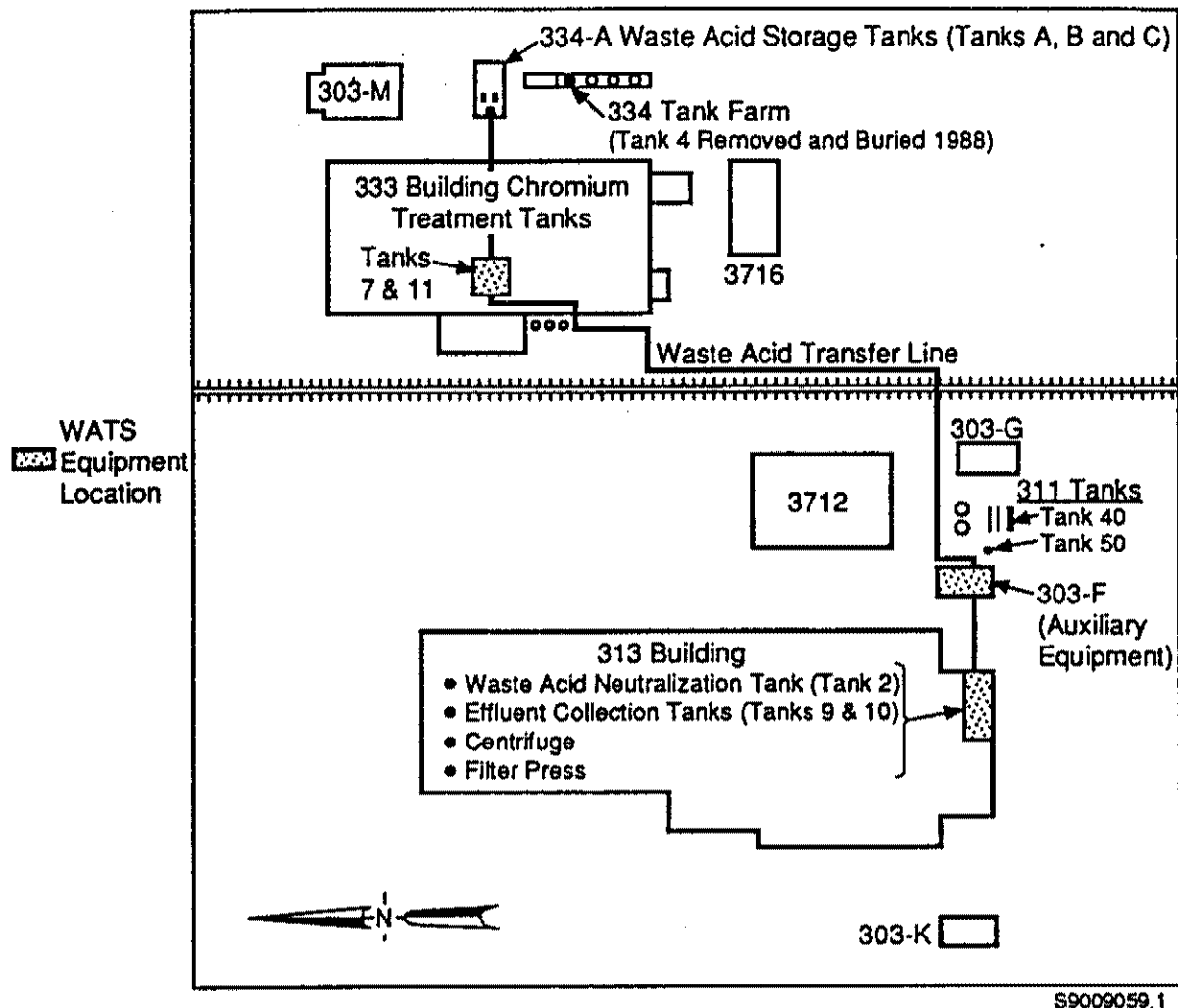
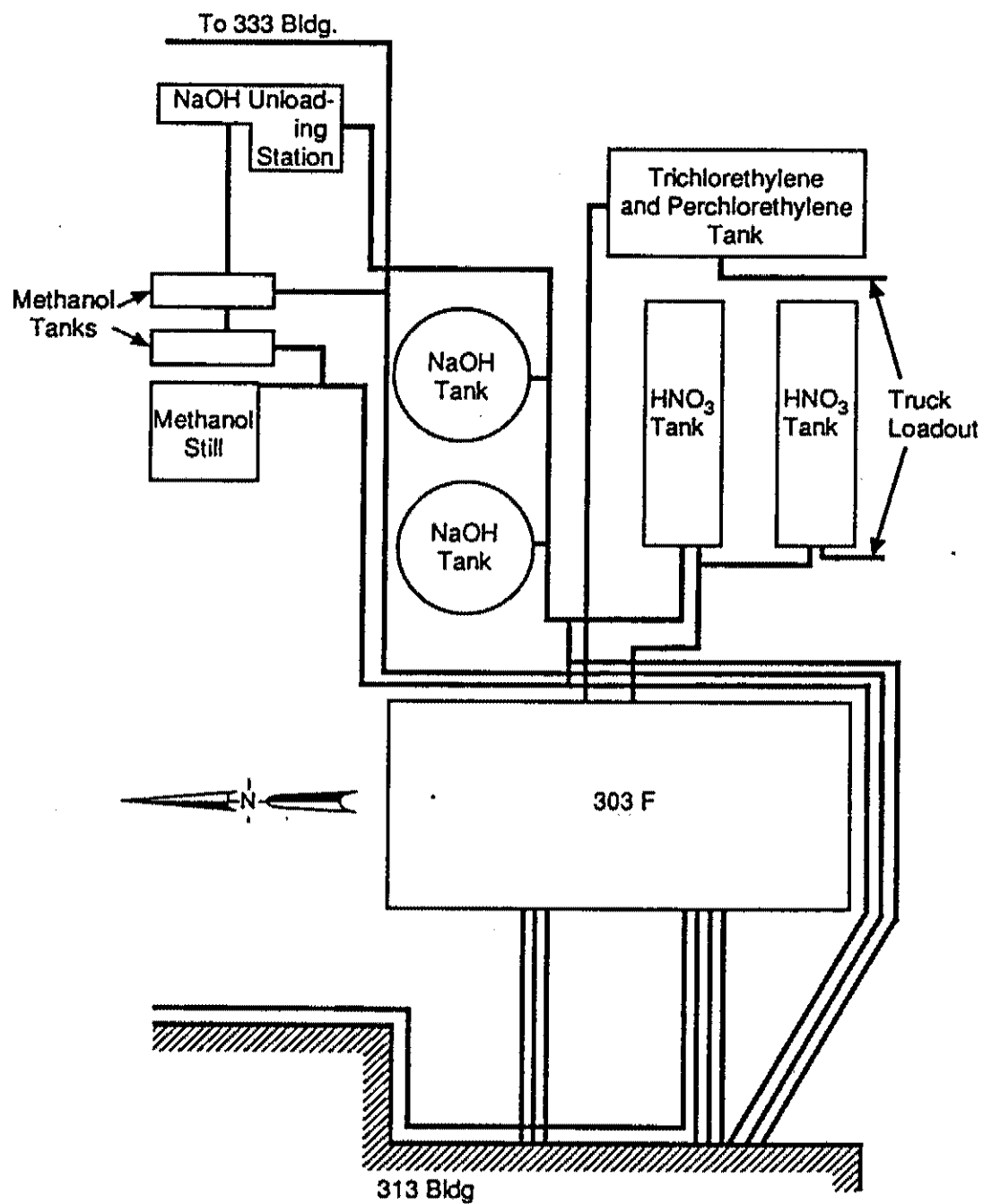


FIGURE 3. 300 Area Waste Acid Treatment System (includes the 311 and 334 Tank Farms)

disposed of separately. Uranium contained in these acids was also recovered prior to discharge. Treated acid waste contained a variety of contaminants, including nitrate, copper, and uranium if the spill occurred before uranium recovery. Additional details concerning the WATS system are in DOE (1990b). A number of spills relating to the WATS are also documented in this reference. Further investigation of these tank farms is recommended before remediation work commences in the 300-FF-1 Operable Unit.



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FIGURE 4. Chemical Pumping and Mixing Facility

TABLE 4. Unplanned Releases from the 311 and 334 Tank Farms and the 300 Area WATS. Further details on these and other releases that went to the Process Sewer can be found in DOE 1990b.

<u>Report Date</u>	<u>Location</u>	<u>Waste Description</u>	<u>Event Description</u>
02/85	313 Building/ Process Sewer	HNO ₃ and H ₂ SO ₄ acids with uranium in solution; HNO ₃ , HF, and CrO ₃ acids with uranium, copper, and zirconium in solution; neutralized acids with precipitates of copper, chromium, uranium, and zirconium	Leak in Process Sewer line from building; it is unknown when the leak started
08/73	Current site of 334-A Building (before building was constructed)	HNO ₃ , HF, and CrO ₃ acids containing copper, uranium, and zirconium in solution	Failure of limestone neutralization tank; some contamination removed
1950 to early 1970s	313 Building/ uranium recovery area	Uranium-bearing acids possibly in neutralized from (see above)	Discovered under floor; from recoverable uranium-bearing acid system; some contamination still present
07/75	334-A and 334 Tank Farm	93% H ₂ SO ₄	Fill line from sulfuric acid; high tank broke; acid drained through limestone pit into Burial Ground 1
1954 to 1986	311 Tank Farm caustic storage area	50% NaOH	Tank overflows and fitting leaks during the years of use; soil around tanks has high pH, requiring chemically resistant clothing when excavating in area
Prior to 10/74	Process Sewer drain from 303-F Building	NaOH solution up to 50% concentration	Drain pipe to the Process Sewer manhole was broken, probably for years
02/85	Overhead pipe in 311 Tank Farm	HNO ₃ and H ₂ SO ₄ acid containing uranium in solution	Freezing of the solution in the pipe caused a gasket to fail; some soil was removed

3.5 COAL ASH AND FILTER BACKWASH

The coal-fired Power House (384 Building), which supplies the 300 Area ²¹⁸ ~~Power~~ with steam, compressed air, and emergency power, has produced ash waste since 1944. Originally, the ash, mixed with water, went to the South Process Pond with process liquids. In 1951 the south part of the pond was diked to form a separate trench for the ash (Photograph A.6). Sometime in 1960-1961 the trench was subdivided into two pits, which are still in use today (Photograph A.20). The trench and pits often filled, and the ash was dug or pushed out, sometimes to the riverbank (Photographs A.21 and A.26) and sometimes to the area between the Process Ponds (Photographs A.34 and A.37).

Backwash water from the filters of the Filtered Water Plant originally went to the Columbia River. In 1976 the backwash water, which could no longer be discharged to the river, was directed into the eastern impoundment of the South Process Pond (Photographs A.32 and A.36). In 1987 a separate pond, next to the ash ponds, was excavated for filter backwash (Photograph A.37).

3.6 BURNING AND BURIAL GROUNDS

Through much of the history of the 300 Area, solid waste, both contaminated and uncontaminated, was burned or buried in pits and trenches. The first burial grounds were established in 1943 for nonretrievable disposal of radioactive waste. The last burial grounds were retired in 1973. In the early days, because of the nature of the Manhattan Project, its relation to national security, and the low priority of expertise in radioactive waste management, little information was kept on burial locations, waste inventories, and forms of waste. The burial grounds did receive mostly uranium-contaminated wastes. However, prior to March 1954 high-level wastes, mainly fission products, were cast into concrete in the 325 Building and buried in unidentified 300 Area burial trenches (Clukey 1954). Phillips et al. (1980) reviewed most of what is known about the 300 Area burial grounds.

There are 10 known burial grounds within the entire 300 Area, two of which, Burial Grounds 4 and 5 (618-4 and 618-5), lie within 300-FF-1 (Plate 1, Appendix C). Burial Ground 6 (618-6), which was just south of the

South Process Pond and the 307 Trenches, was excavated and removed. There are several numbered burial grounds near 300-FF-1 and a number of unrecorded or unknown burial and burn grounds (Plates 1 and 2, Appendix C), some of which have been identified inside 300-FF-1 by aerial photographs.

Two designated burial grounds (4 and 5) are within 300-FF-1. Burial Ground 4 (618-4) covers about 3800 m² in a northeastern-southwestern direction within the northwest corner, about 90 m west of the Columbia River. Its depth, contents (other than it contains uranium-contaminated miscellaneous materials), and amount of fill are unknown. In 1979, 20 aluminum-canned depleted uranium fuel elements were discovered protruding from the surface of the soil at the site, probably buried there 10 to 15 years earlier. They were removed and the area decontaminated. The burial ground is visible in Photograph A.17, which was taken in 1956 not long after the pit became active. The burial ground was reportedly used until 1961 (Stenner et al. 1988).

Burial Ground 5 (618-5) was used for the incineration and burial of uranium-contaminated (dose rate <1 mrad/h) and nonradioactive trash collected from the 300 Area (see Photograph A.30). Part of its contents include 17 crucibles contaminated with aluminum-silicon or lead having activity levels <200 mrad/h (Phillips et al. 1980). According to Paas (1955), the pit was covered with about 1 ft of soil on August 28, 1953, and posted as a radiation zone. However, Stenner et al. (1988) report that the site was used as a burial and burning ground until 1962, finally being covered with 4 ft of clean soil. A plume of smoke can be seen coming from the site in Photograph A.7, taken January 30, 1952.

By 1951 and possibly earlier, paper and other building waste were burned in a steel mesh cage directly east of Burial Ground 5, close to the river (Photograph A.10). The cage still exists today (Photograph A.39). Teel and Olsen (1990) included as part of a surface radiation survey of 300-FF-1 the area around the cage and found numerous contaminated sites with debris ranging from steel drums to laboratory equipment (Photograph A.40). Photographs A.4, A.11, A.14, and A.17, taken between 1948 and 1956, indicate

excavation and disposal activity next to the river, including at least two burial trenches. No documentation of these trenches has been found.

Another pit used for the incineration of debris was dug in 1962, north of the septic tank for the Sanitary Leach Trenches. It can be seen as a newly constructed excavation in Photographs A.22 and A.23. It contained debris in Photographs A.25 and A.27. This pit was used as an alternate burning ground in conjunction with burning in Burial Ground 5. The pits were used alternately to allow them to cool between burnings. Some incidental radioactive materials may have been burned here, but the pit was mainly for paper, wood, paint cans, and other operations debris. In Photograph A.28, taken in May 1974, the pit has been decommissioned and filled.

A mound located just east of the 307 Trenches, within 300-FF-1, contains construction rubble. Photograph A.31 shows a depression in the ground, which was left from the excavation of fill dirt for the 337 and 338 Buildings. This hole was used for dumping concrete and other construction debris (Photograph A.33). The rubble was eventually smoothed over.

Uranium metal was inadvertently burned on occasion outside the 313 Building in 5-gallon pails that had been used to collect scraps and cuttings which are pyrophoric. These would spontaneously ignite and flame, probably spreading uranium contamination. 313 scrap (G. 10)

Several other burial grounds lie just outside 300-FF-1. A disturbed area in Photograph A.1, a few hundred feet west of the tile field, is the site of Burial Ground 1. Photograph A.3 shows a hint of excavation at the site, and it can be seen in Photograph A.4. Subsequent photographs reveal only a fenced area. It contains dry uranium, plutonium, and fission products of unknown quantities.

Burial Ground 2 (618-2) can be seen in Photograph A.11. It contains uranium waste such as solid metallic oxides in the form of metal cuttings, uranium-contaminated equipment, plutonium, and fission products. Burial Grounds 1 and 2 also contain large amounts (tons) of tin from the triple dip canning process and lead from the lead-dip process. Burial Ground 2 was decommissioned in 1954, replaced by Burial Ground 3. tin
lead

Burial Ground 3 (618-3), seen in Photographs A.13, A.15, A.16, and A.17, was principally used for disposal of material derived from the 313 Building.

Burial Ground 6 (618-6) was created for low-level dry waste during 1943 and 1944 in the southeast corner of the 300 Area, at or near the location of the present 325 Building. Sometime prior to late 1951 when new facilities were constructed, the material was moved south of the South Process Pond at the site of the present 324 Building, covered by about 6 ft of clean soil, surrounded by a wood fence, and posted with radiation signs (Photographs A.6 and A.19). The total radioactivity buried there was not known. The entire fenced area can be seen in Photograph A.6. This burial ground was removed during late 1962 or early 1963 for construction of the 324 Building.

Burial Ground 8 (618-8) was used mainly for the disposal of dry, solid waste derived from reactor fuels manufacturing, with uranium cuttings from the fabrication of fuel pins (Phillips et al. 1980). It has been represented on maps as a single trench, 600 ft long, located under the north parking lot, and its boundaries are delineated by brass markers set into the asphalt. A recent geophysical survey of the site that included ground-penetrating radar, a magnetometer, and a metal detector, found large volumes of waste material buried at the north end of the designated trench and substantial amounts outside its northern boundaries. Disturbed areas can be seen in Photographs A.12, A.15, A.16, A.17, and A.22. An undesignated burial ground was recently discovered on the west side of the Process Trenches, just outside the 300-FF-1 boundary (Photograph A.37 and Plate 1). No information was found on its history or contents.

Locations of some buried items are no longer known. Two examples are a radioactively contaminated pick-up truck and some lithium-aluminate target elements. These were buried outside the designated burial grounds and may or may not be within 300-FF-1.

Phillips et al. (1980) discussed the principal routes of contaminant migration from the burial grounds and concluded that wind was the most likely pathway. Wind can erode the backfill material and expose and distribute the buried waste. This pathway could be exacerbated by harvester ant colonies

that tunnel in the sites and transport kilogram quantities of soil each year to the surface from as deep as 3 m.

3.7 THE PLUTONIUM RECYCLE TEST REACTOR AND THE PLUTONIUM FINISHING PILOT PLANT

Two facilities were begun in 1958 that used sewage process, retention process, and radioactive waste systems. One, the Plutonium Recycle Test Reactor (PRTR), designed to develop technology for using plutonium as a fuel in thermal heterogeneous power reactors, was in service from 1960 to 1969, when the reactor was placed in layaway. The other facility, the Plutonium Finishing Pilot Plant (PFPP), also called the 308 Plutonium Laboratory, provided laboratory space for developing technology for the manufacture of plutonium-bearing fuels.

The PRTR process, radioactive sewers, and sanitary sewers are diagrammed in Figures 5 and 6. The reactor used recirculating heavy water, which eliminated the use of single-pass process water, so process water did not enter the high-neutron flux region. Several low-level radioactive waste streams were discharged to the Columbia River through Manholes 2 or 3, which were monitored for gross beta-gamma activity. Contaminated waste was stored in "hold-up" tanks for transfer to the 340 Complex. Storage basin overflow went to hold-up tank TW-3, where it was sampled before the tank was emptied to either Manhole 2 or the 340 Complex (Hard and Koberg 1959). The carbon steel radioactive waste line going to the 340 Complex is discussed in Young et al. (1990). Excavation of the trench for this line can be seen in Photograph A.18.

The PFPP was connected to both the old RLWS and the Retention Process Sewer. Photograph A.18 show the Retention Process Sewer being installed.

A burial pit to the southeast of the facilities, outside 300-FF-1, was used for construction rubble (Photograph A.19). The pit was covered over sometime in the late 1960s.

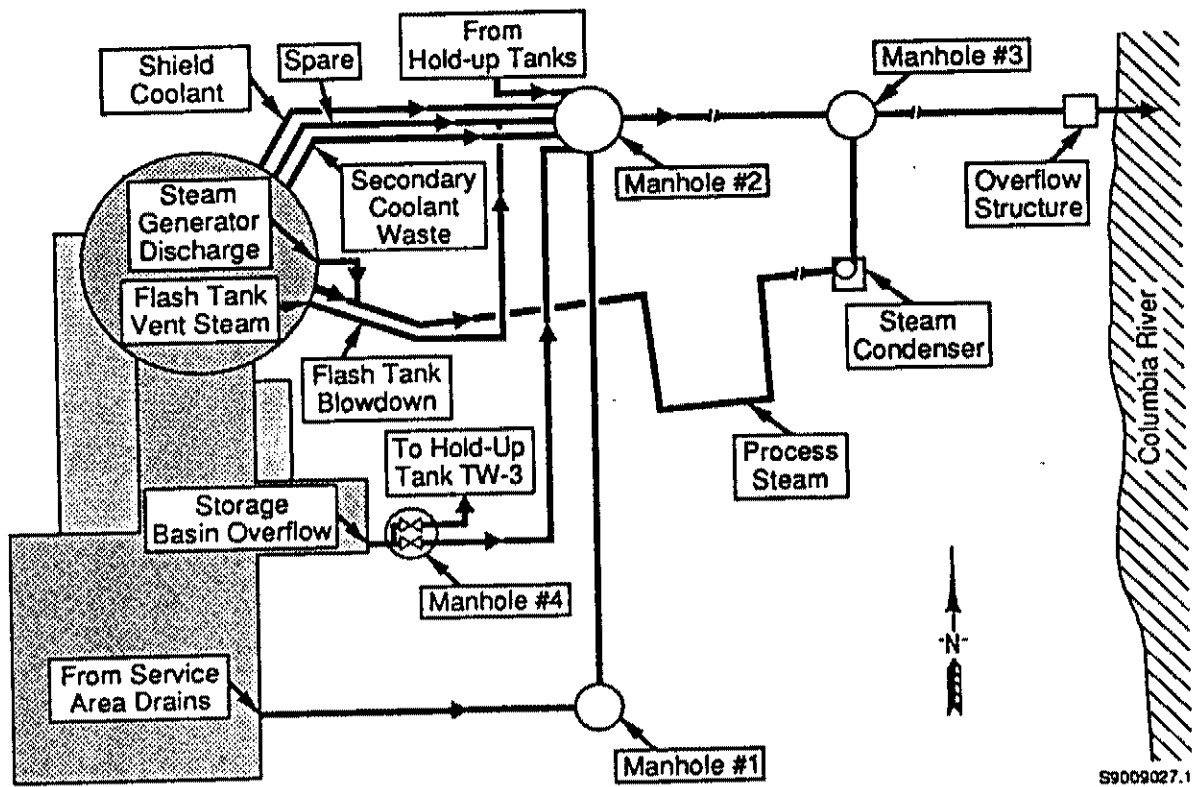
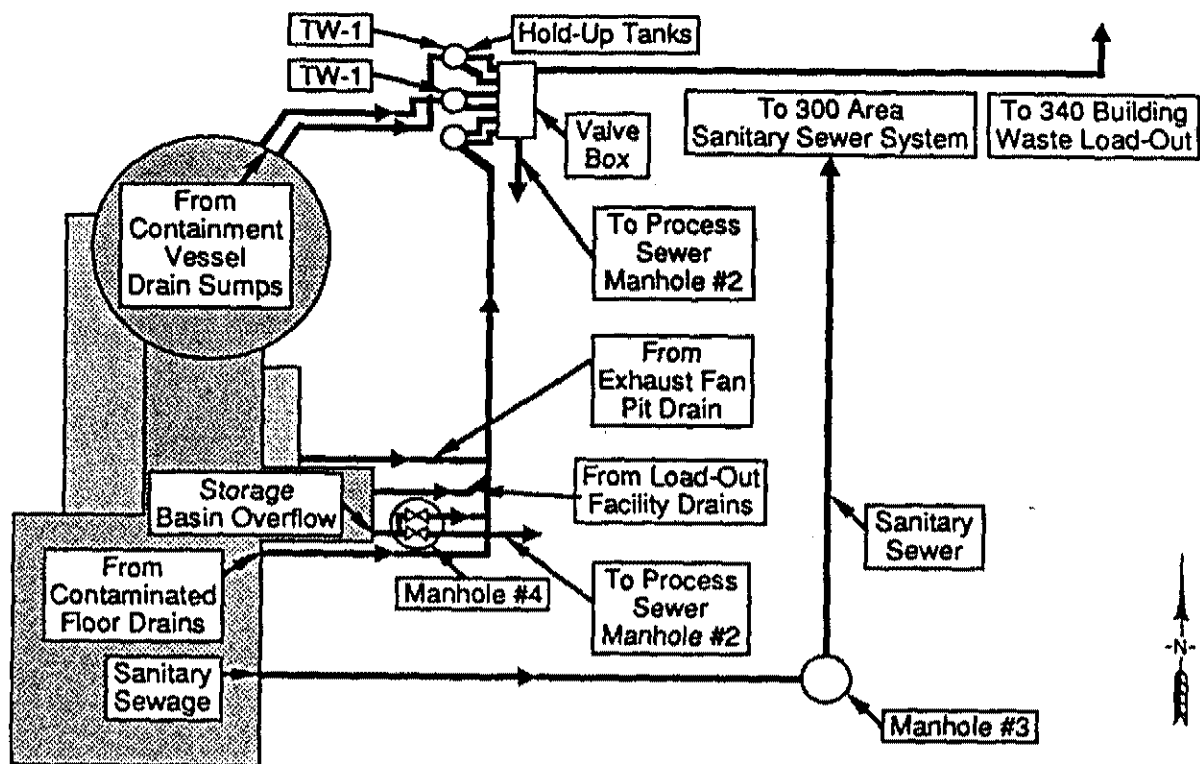


FIGURE 5. PRTR Process Sewer System



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FIGURE 6. PRTR Contaminated and Sanitary Sewers Process

4.0 CONCLUSIONS AND RECOMMENDATIONS

Several undesignated burning and solid waste burial sites, both within and outside of 300-FF-1, were located using aerial photographs. Some may contain hazardous chemicals or radioactive materials. Chemicals from the fuels fabrication processes that were routinely disposed of as liquid process wastes to the North and South Process Ponds have been identified. New information is included on unplanned releases from the chemical storage and waste acid treatment tanks (Table 4).

The boundaries of undesignated burial grounds remain undetermined, and designated burial grounds may have debris buried outside their boundaries. The burial sites of the contaminated pick-up truck and the lithium-aluminate target elements are still unknown. There may be other unidentified objects and debris buried in as yet undisclosed locations. It is recommended that geophysical surveys that include ground-penetrating radar, magnetometry, and metal detection be conducted in undesignated burial grounds, suspect areas, and any area that may be excavated in the future to ascertain the nature and whereabouts of buried debris. In addition, further investigation of spills from the tank storage facilities is advised.

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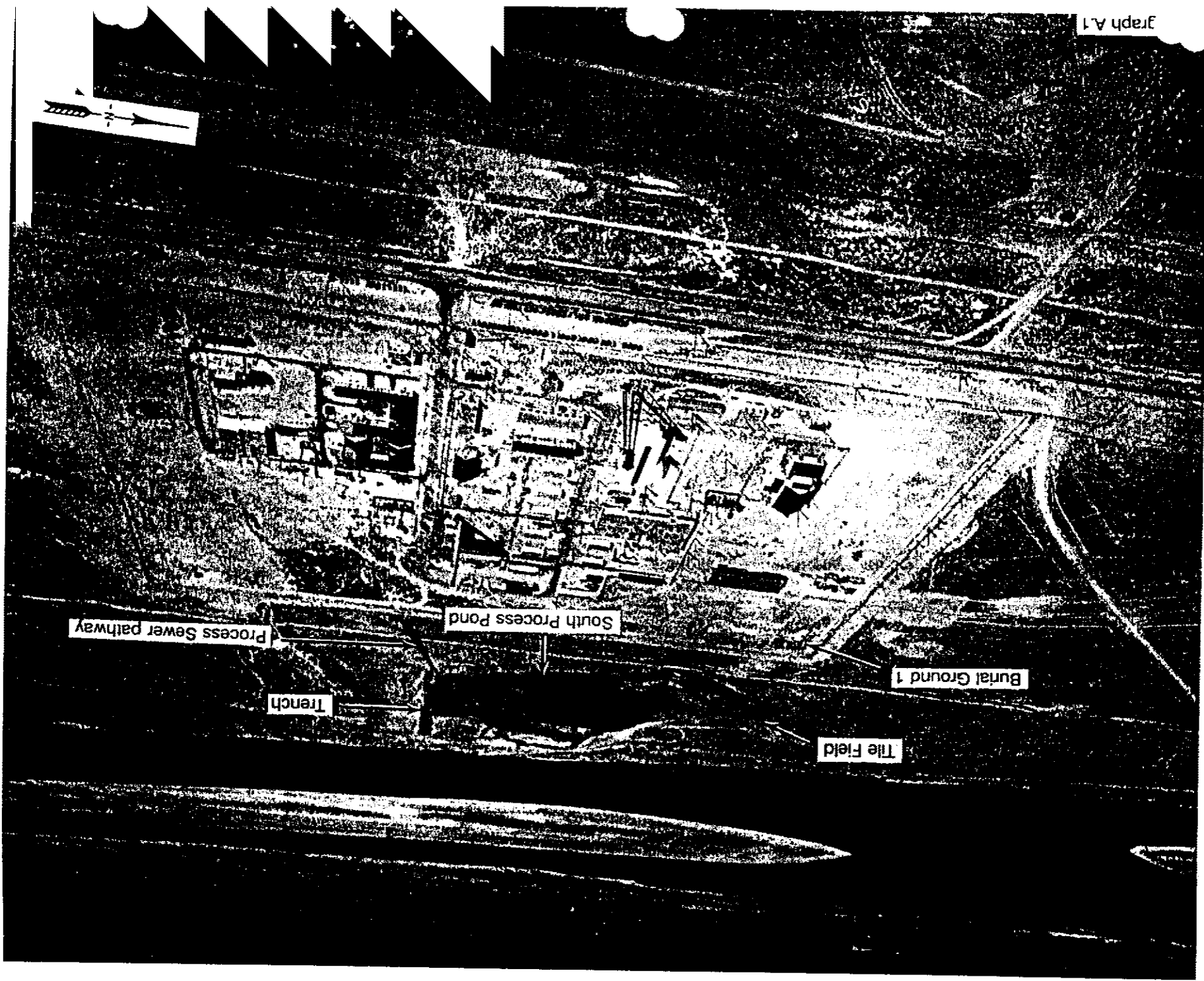
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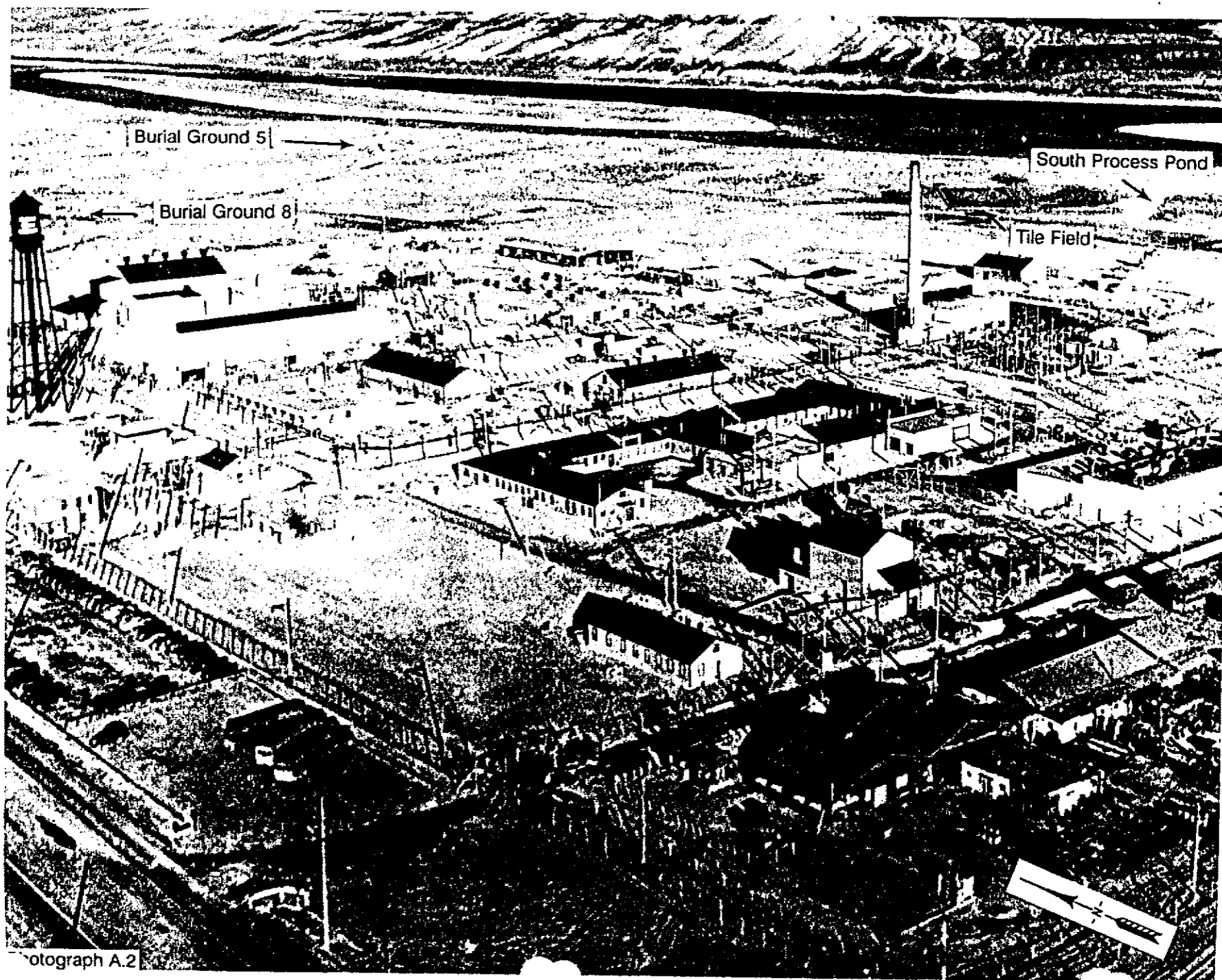
APPENDIX A

A.1

PHOTOGRAPH A.1. 1944. This photograph shows the South Process Pond (316-1). Process waste emptied into a trench on the south side before entering the pond. The pathway for the Process Sewer is indicated. The tile field, a leach field for sewage waste, can be seen just north of the pond. Standing water in the tile field indicates that it has exceeded its capacity. Burial Ground 1, west of the tile field, is fenced but does not appear active (Negative No. 90091801-30CN).

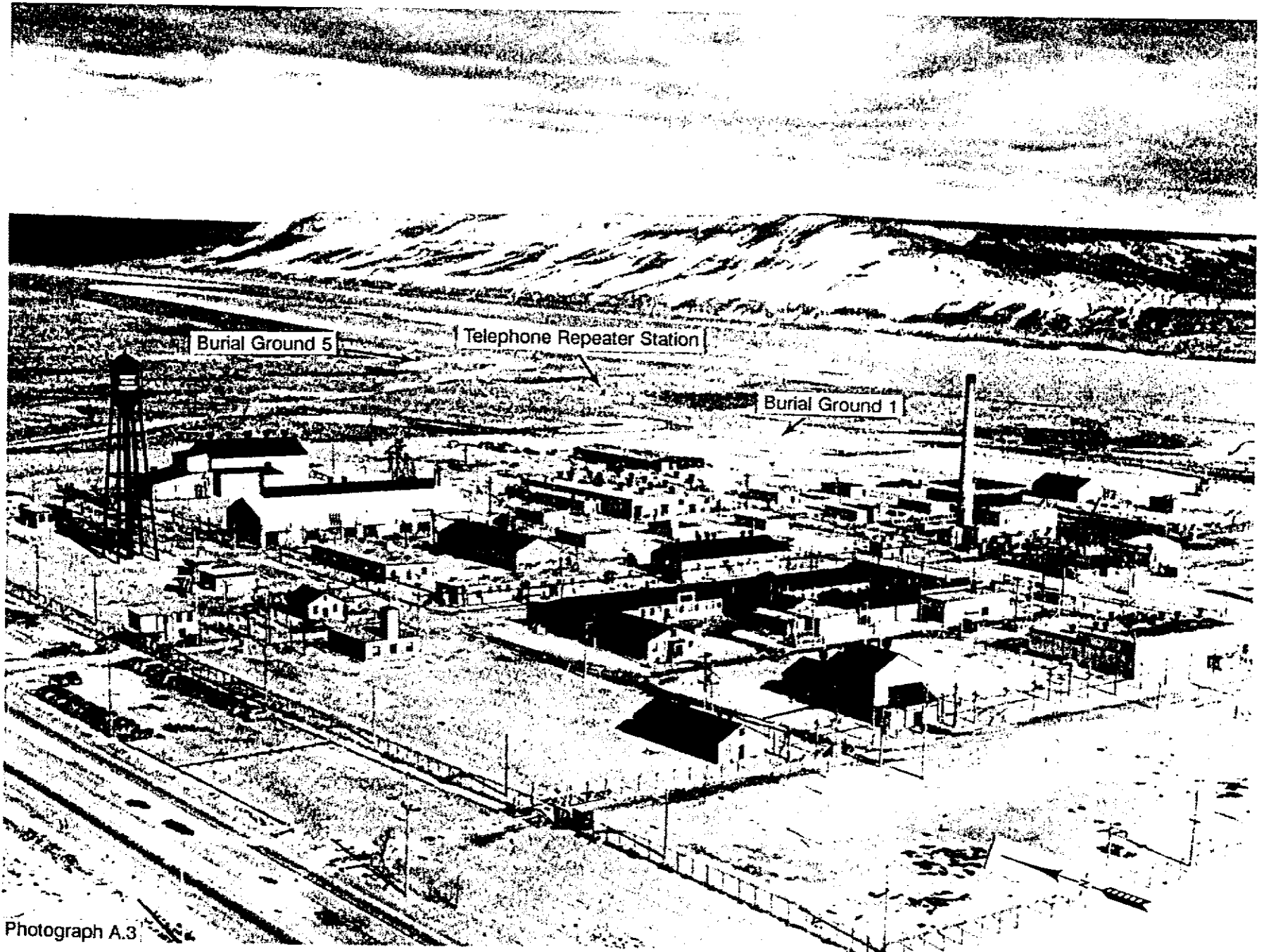


PHOTOGRAPH A.2. 1944. Part of the South Process Pond (316-1), the tile field, Burial Ground 5 (618-5), and some possible ground disturbance at the site of Burial Ground 8 (618-8) can be seen in the upper portion of the photograph. The buildings in the lower right corner were temporary storage sheds for equipment and supplies used during construction of the 300 Area (No. 90092011).



A.5

PHOTOGRAPH A.3. 1944. This photograph shows piles of dirt at Burial Grounds 1 and 5, and the telephone repeater station, which is the small building near the middle of the figure. The picture was taken just after completion of the original 300 Area buildings and dismantling of the storage sheds (Negative No. 64279).



Photograph A.3

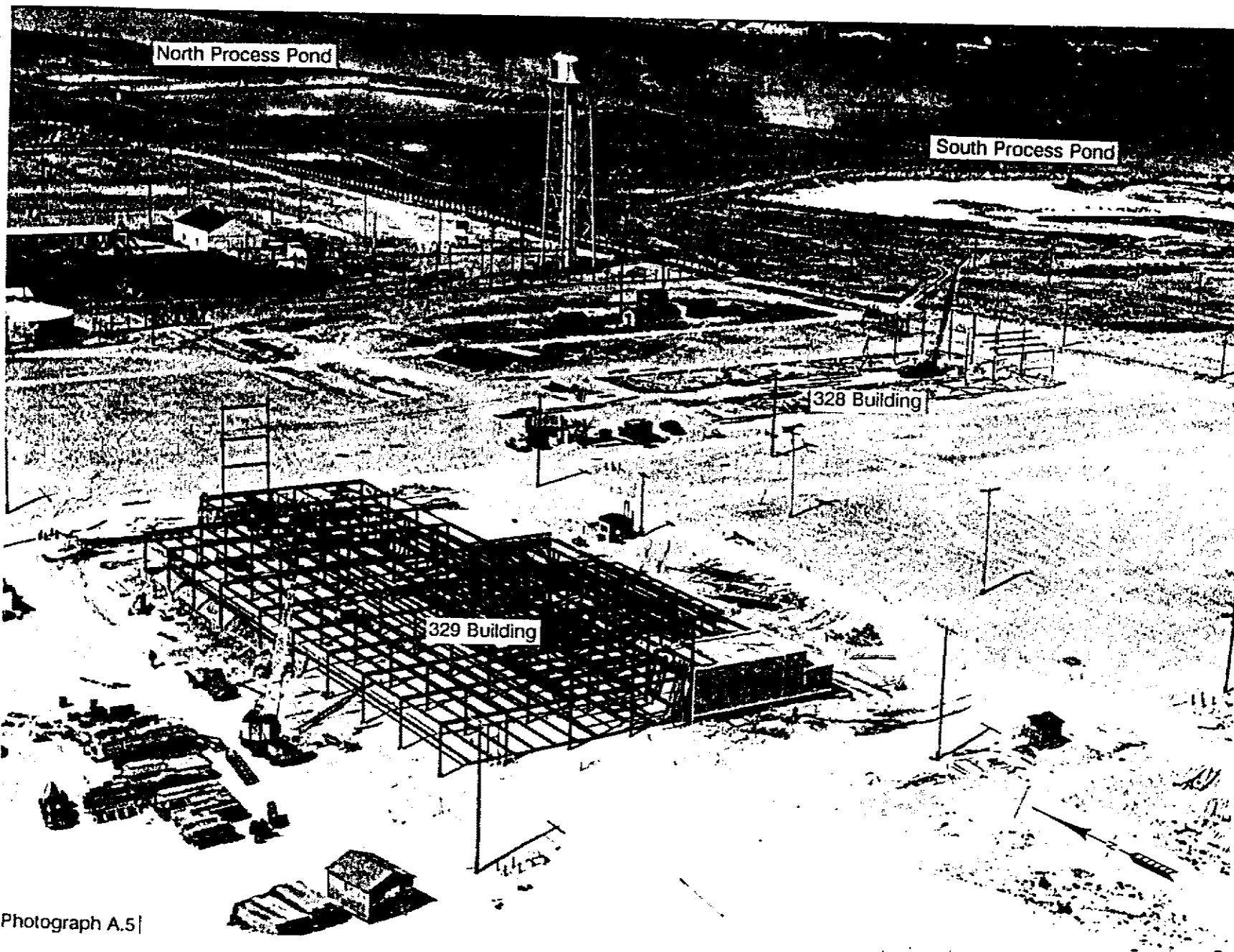
PHOTOGRAPH A.4. May 24, 1948. This photograph shows the South Process Pond, the tile field, the first Sanitary Leach Trench, Burial Ground 1 with a pit at the southern end, Burial Ground 5, and burial trenches along the Columbia River. The barren area north of the 300 Area was a rail loading area for aluminum scrap from the 313 Building (Negative No. 90070235-1).



Photograph A.4

A.9

PHOTOGRAPH A.5. May 29, 1951. The South Process Pond (316-1) is drained. The light-shaded sediment is probably aluminum hydroxide that sealed the bottom. New buildings are being framed. In the foreground is the 329 Building. The 328 Building is just beginning to be framed (Negative No. 90061562.2).

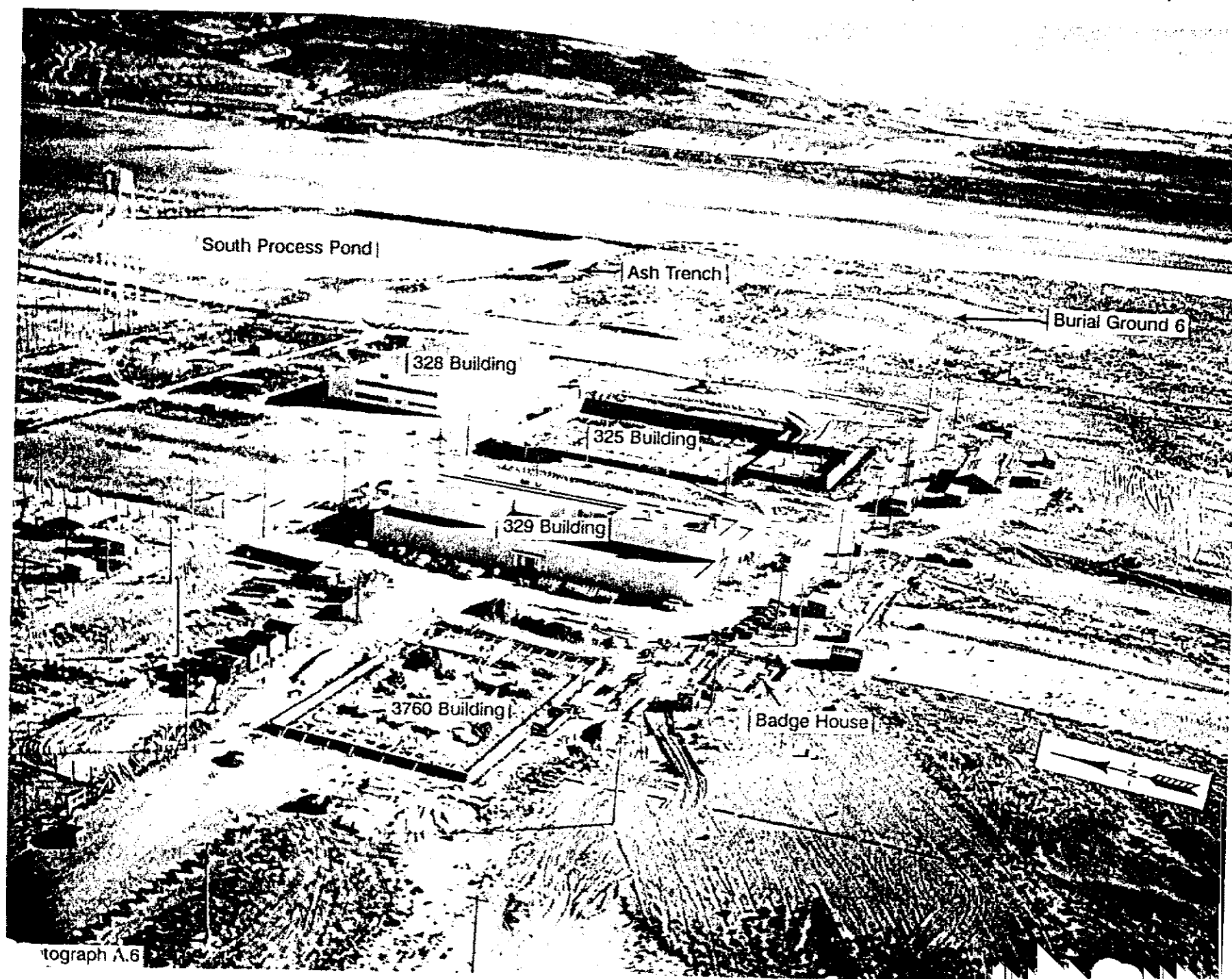


A.10

Photograph A.5|

A.11

PHOTOGRAPH A.6. October 30, 1951. The south end of the South Process Pond has been separated with a dike to form a trench for coal ash. Burial Ground 6 is a fenced area south of the pond. Shown in the photograph are footings and forms for the 3760 Building (Library and Files), the Badge House, the 329 Building, the foundation for the 325 Building, and the 328 Building (Negative No. 286).



Photograph A.6

A.13

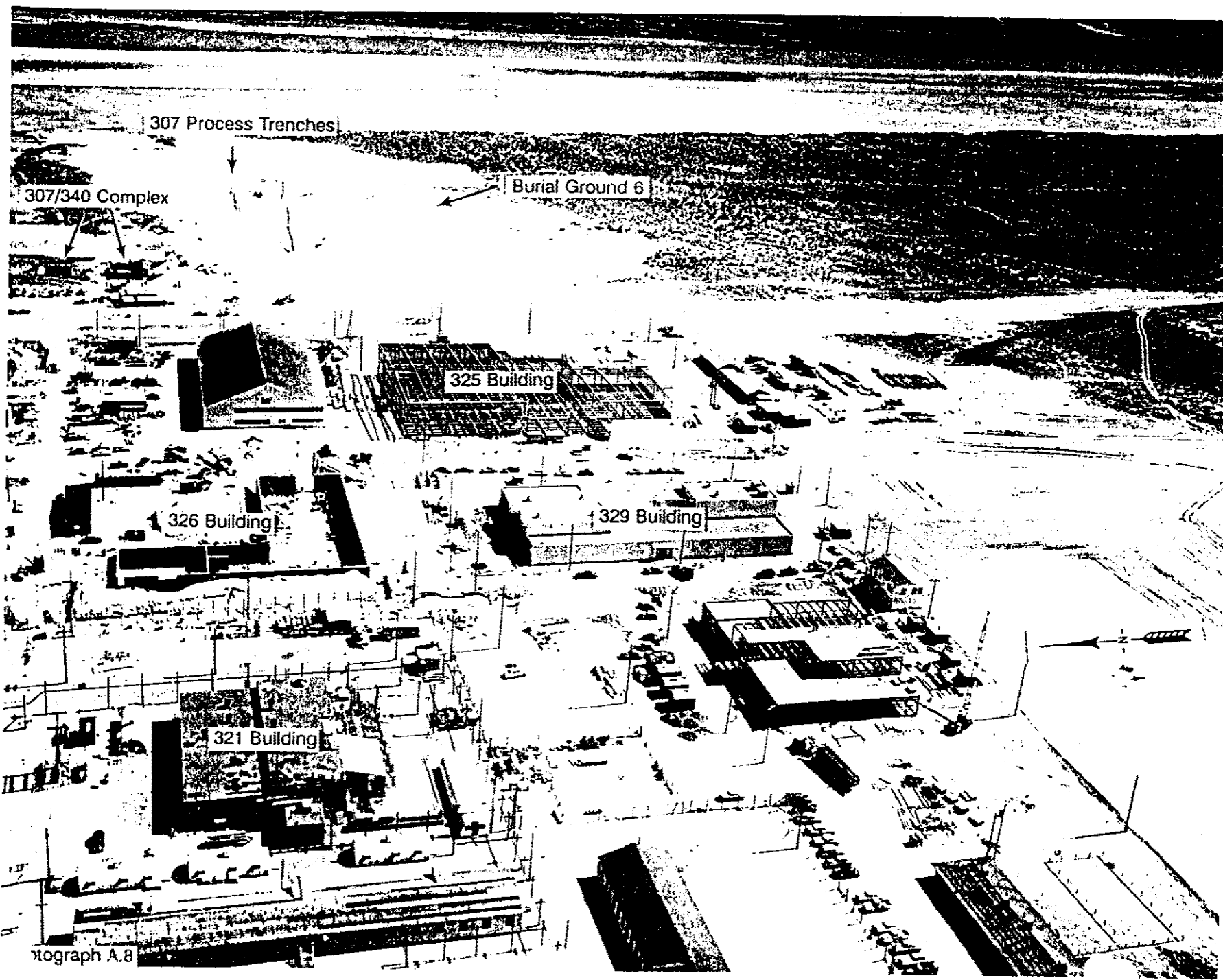
PHOTOGRAPH A.7. January 30, 1952. A plume of smoke can be seen in the upper left section of the photograph coming from Burial Ground 5. The North and South Process Ponds were in use (Negative No. 377).



Photograph A.7

A.15

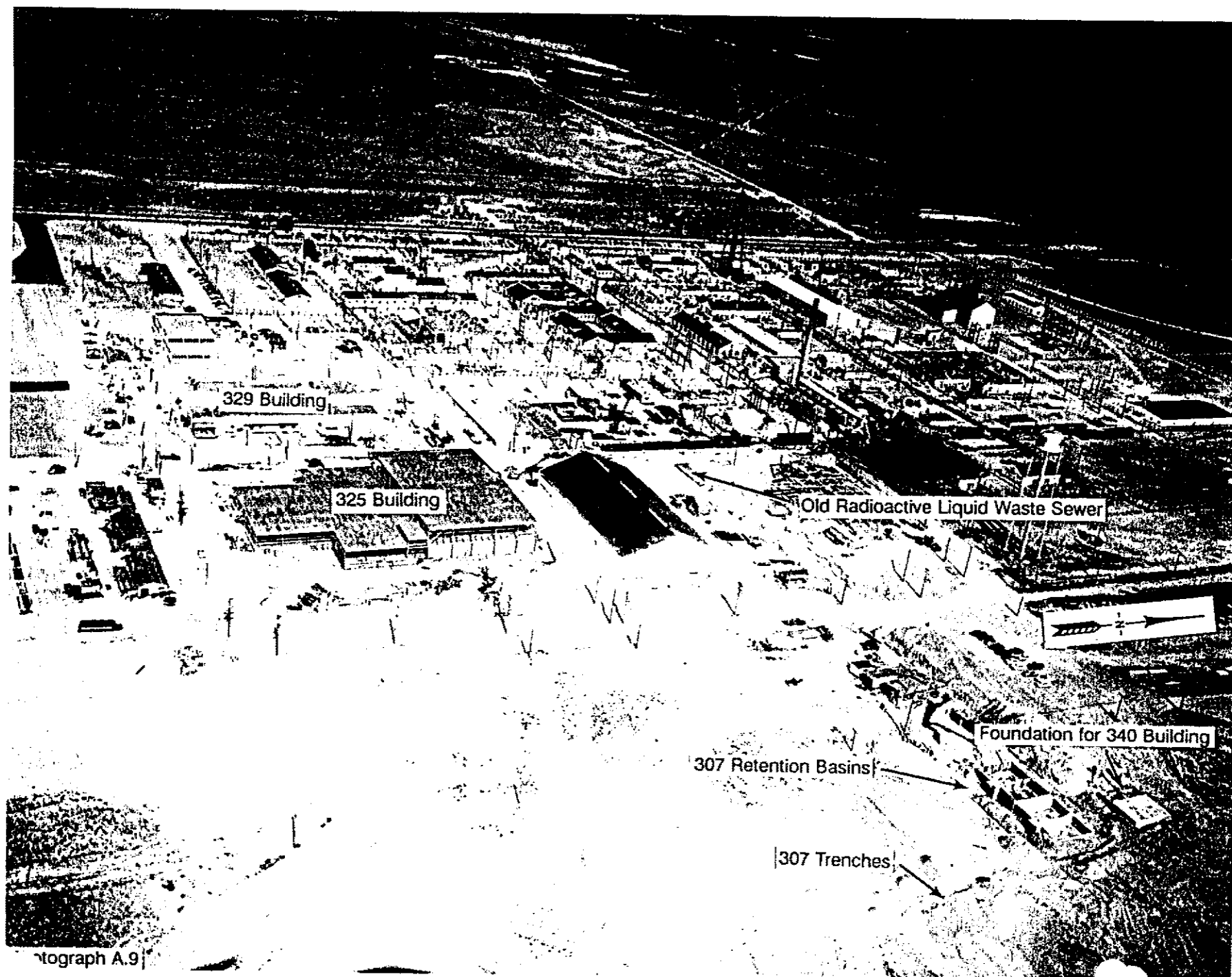
PHOTOGRAPH A.8. March 31, 1952. The newly excavated 307 Process Trenches can be seen in the upper left portion of the photograph. Forms have been installed for pouring the 307 Basins and the foundation of the 340 Facility. The fenced area next to the trenches is Burial Ground 6. The 321 Building, partly surrounded by the Quonsets, is in the lower left. (Negative No. 400).



A.16

A.17

PHOTOGRAPH A.9. May 27, 1952. Construction is underway on the 307/340 Complex. The 307 Retention Basins and the heads of the 307 Trenches, in the lower right portion of the photograph, are connected with 8-inch pipes. The old Radioactive Liquid Waste Sewer line is visible just below the rail cars. (Negative No. 420).



Photograph A.9

A.19

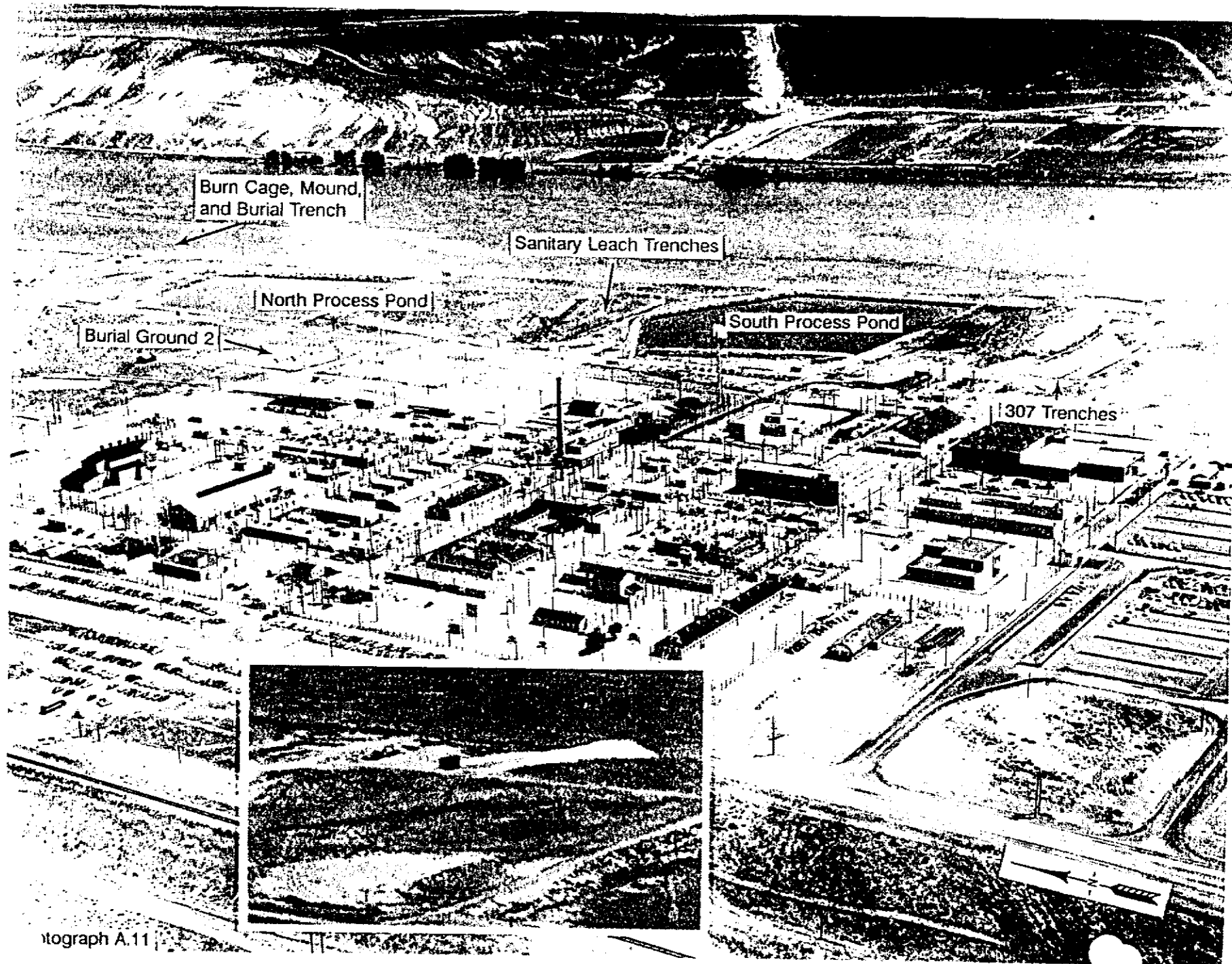
PHOTOGRAPH A.10. July 31, 1952. Both Process Ponds are full. The burn cage can be seen north of the North Process Pond. (Negative No. 449).



Photograph A.10

A.21

PHOTOGRAPH A.11. June 8, 1953. In front of the North Process Pond is Burial Ground 2 (618-2). Behind the burn cage, near the edge of the Columbia River, is a newly constructed mound (see enlarged insert). This mound still exists, and protruding from it are concrete rubble, pipes, iron bars, and barrels. Just to the north of the burn cage is a burial trench (Negative No. 2052).



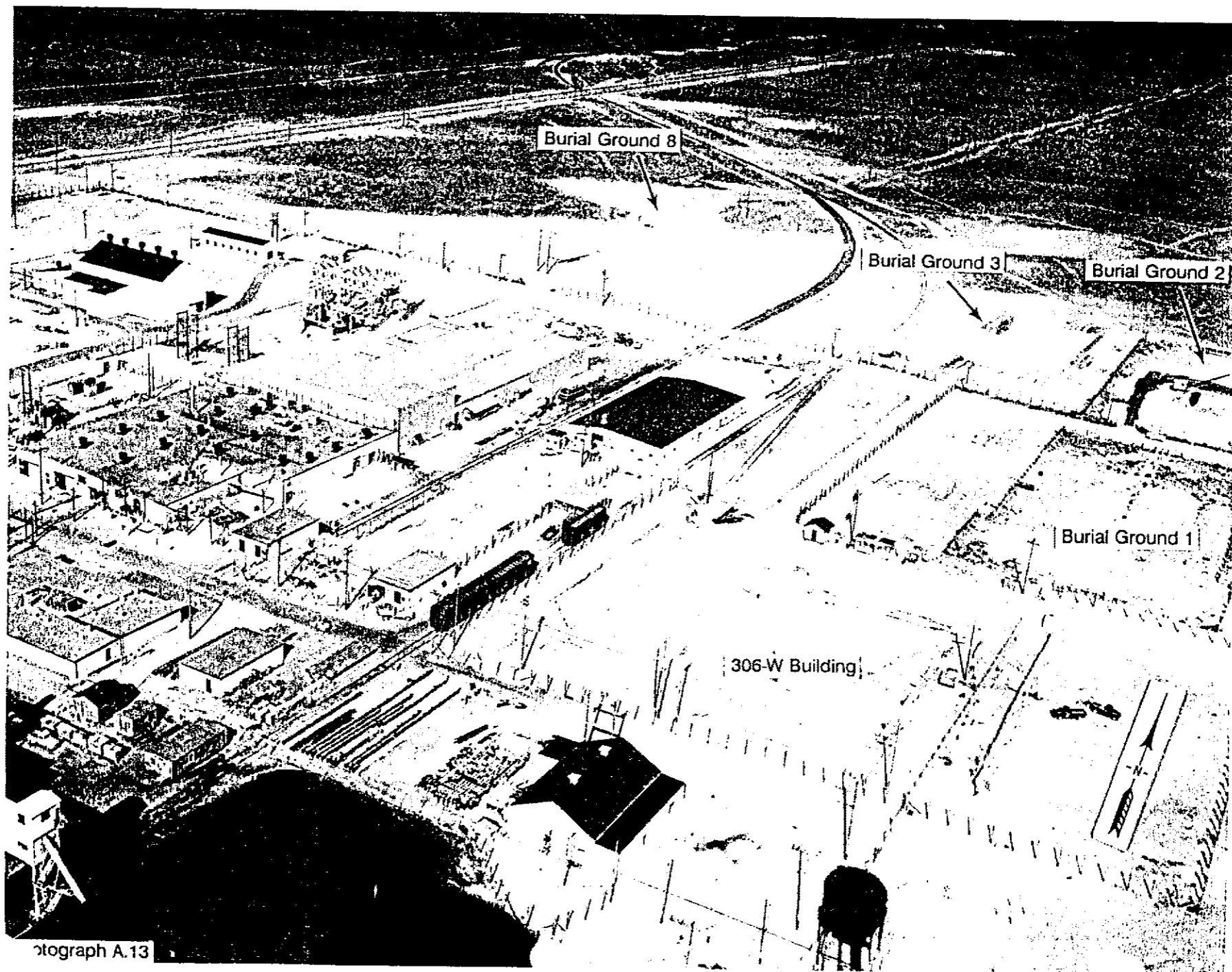
Photograph A.11

A.23

PHOTOGRAPH A.12. December 1, 1953. Burial Ground 2, the trench containing debris, is in the foreground. Burial Ground 1 is the fenced area to the left. (Negative No. 2406).

A.25

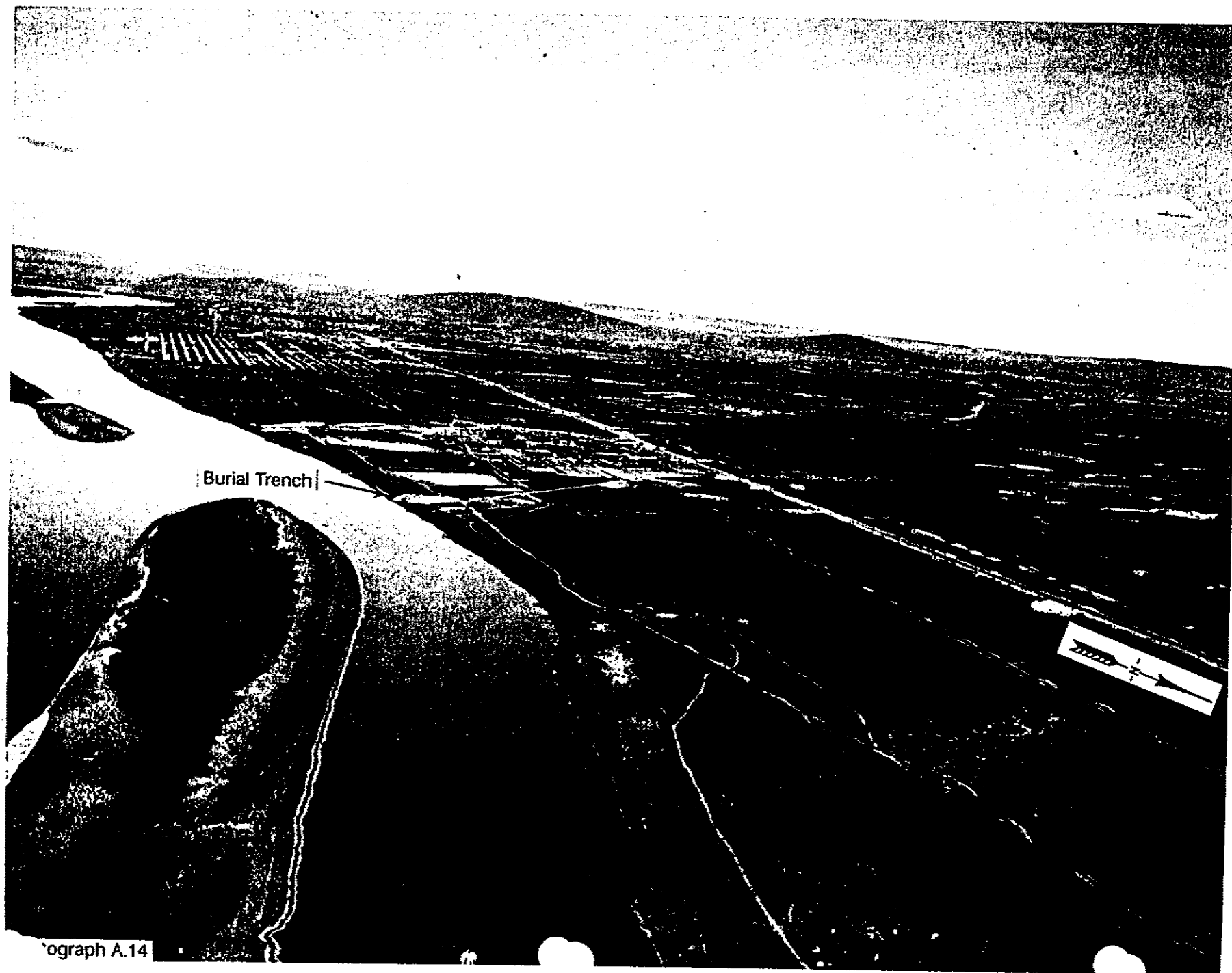
PHOTOGRAPH A.13. March 1954. Burial Ground 2 is being covered, and Burial Ground 3 (618-3) has just been dug. Burial Ground 1 is the T-shaped fenced area on the right side of the photograph. Near the top of the photograph to the left of the railroad is an area with dirt mounds. The location appears to be at the site of Burial Ground 8 (618-8). The concrete foundation in the foreground is for the 306-W Building (Negative No. 2530).



Photograph A.13

A.27

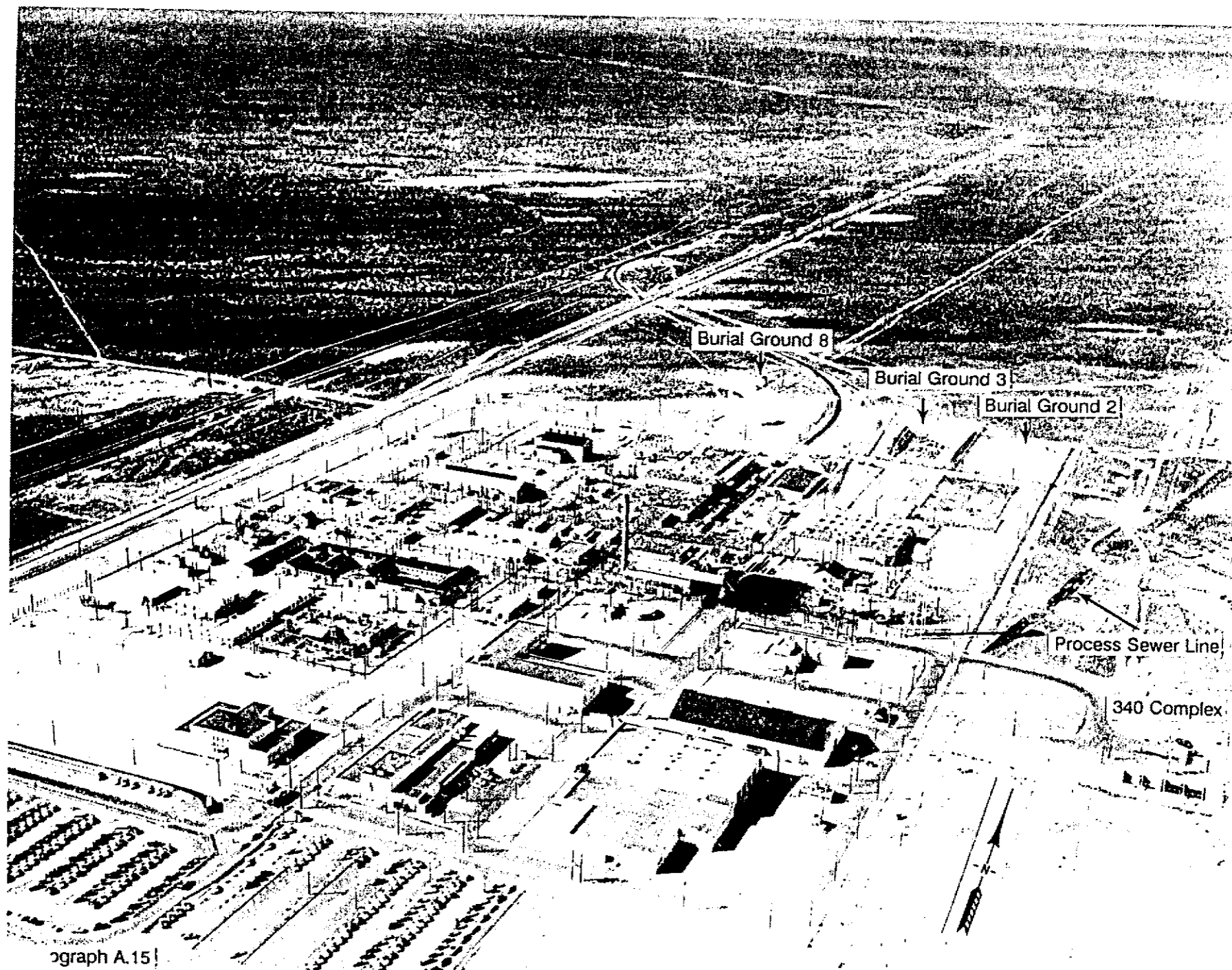
PHOTOGRAPH A.14. April 1954. This photograph shows some scarring of the landscape north of the 300 Area that may be related to waste disposal (Negative No. 2674).



ograph A.14

A.29

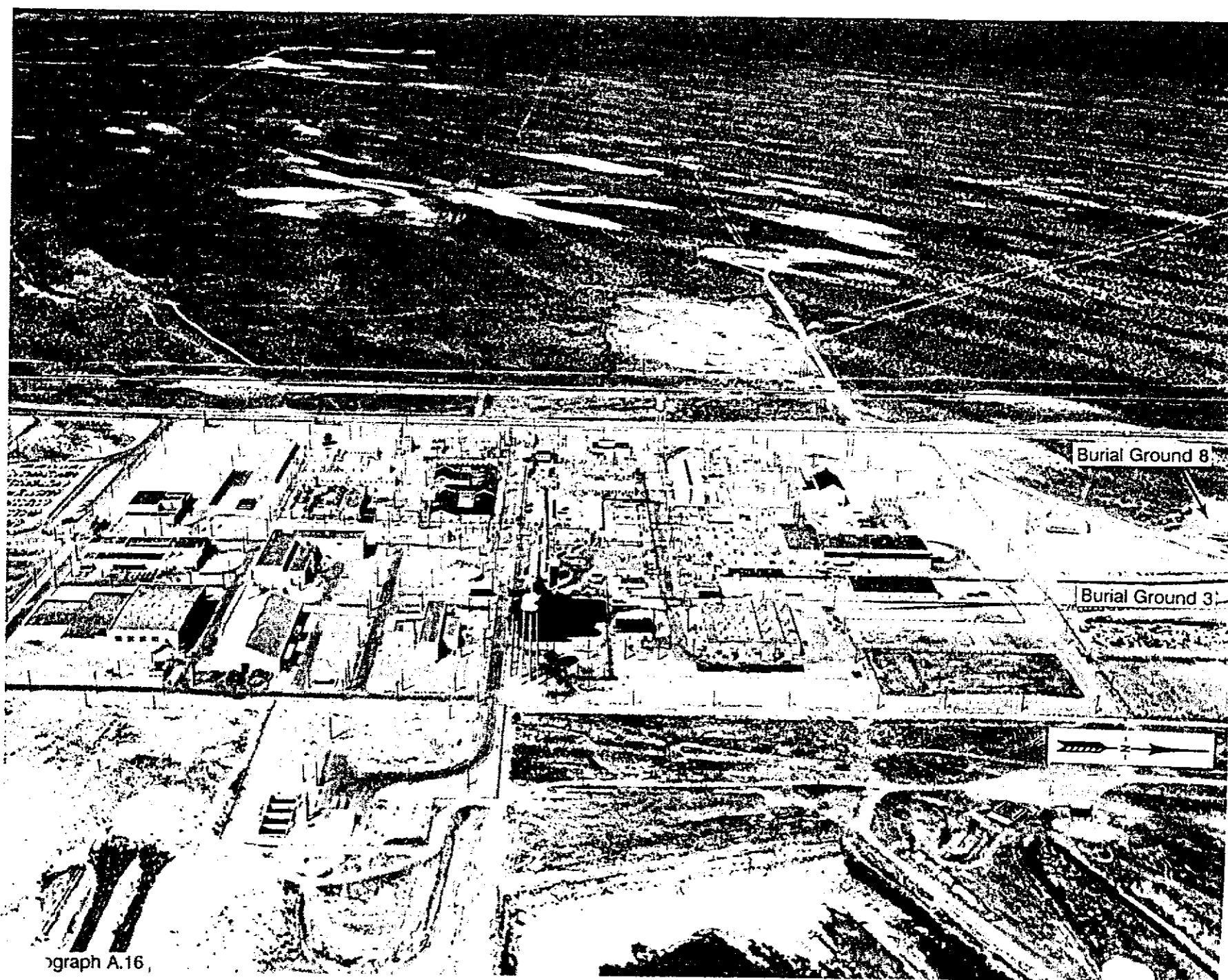
PHOTOGRAPH A.15. April 7, 1955. Burial Ground 2 has been filled, and Burial Ground 3 is in use. Mounds of dirt can be seen at the location of Burial Ground 8. The trench containing the Process Sewer Line is on the right side of the photograph. A tanker truck can be seen at the 340 Complex (Negative No. 3352).



ograph A.15

A.31

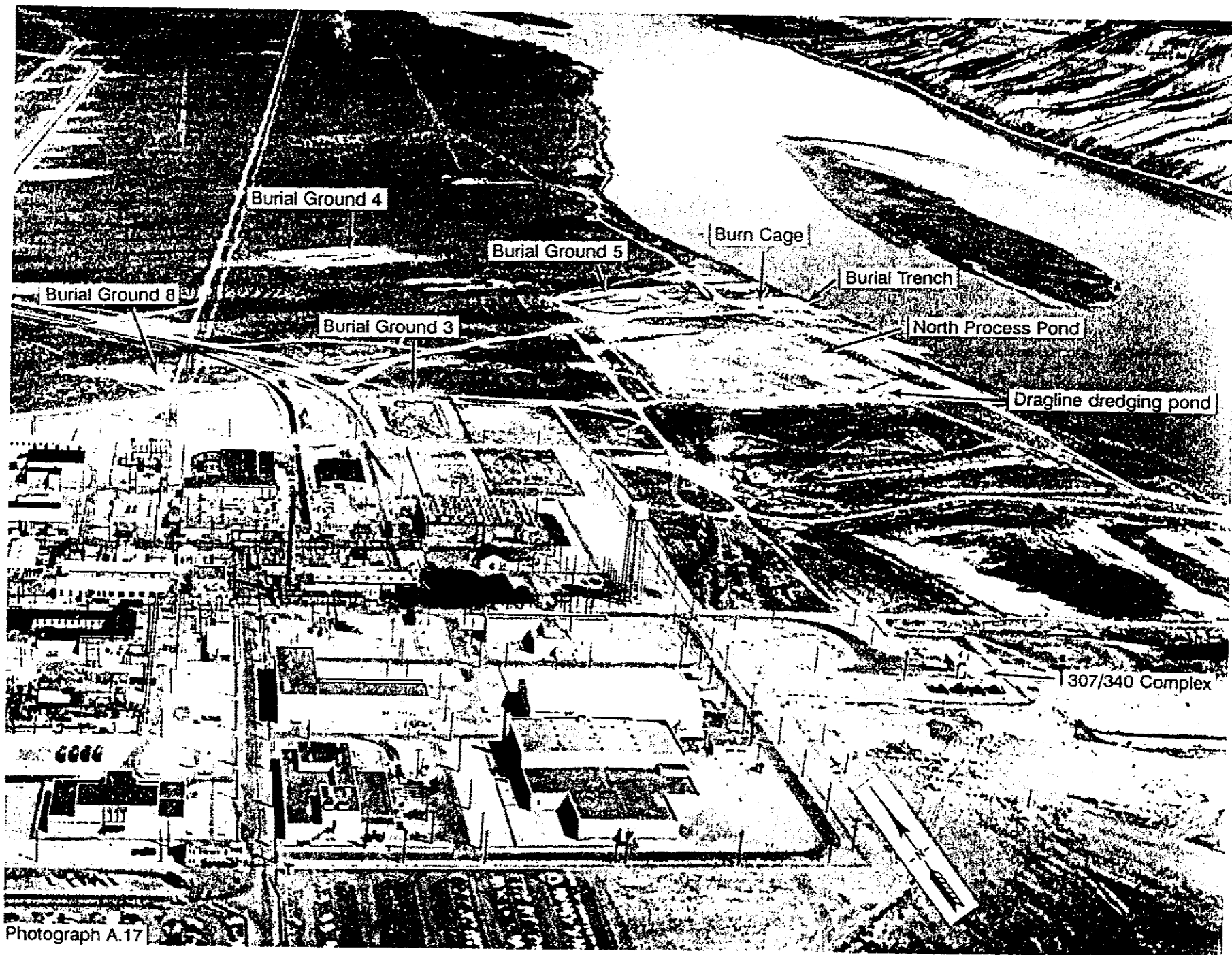
PHOTOGRAPH A.16. May 15, 1956. Burial Ground 3 in the right of the photograph is open and contains debris. In the top half of the photograph, to the west, are the 300 Area burial grounds, which are not discussed in this report (Negative No. 3746).



ograph A.16

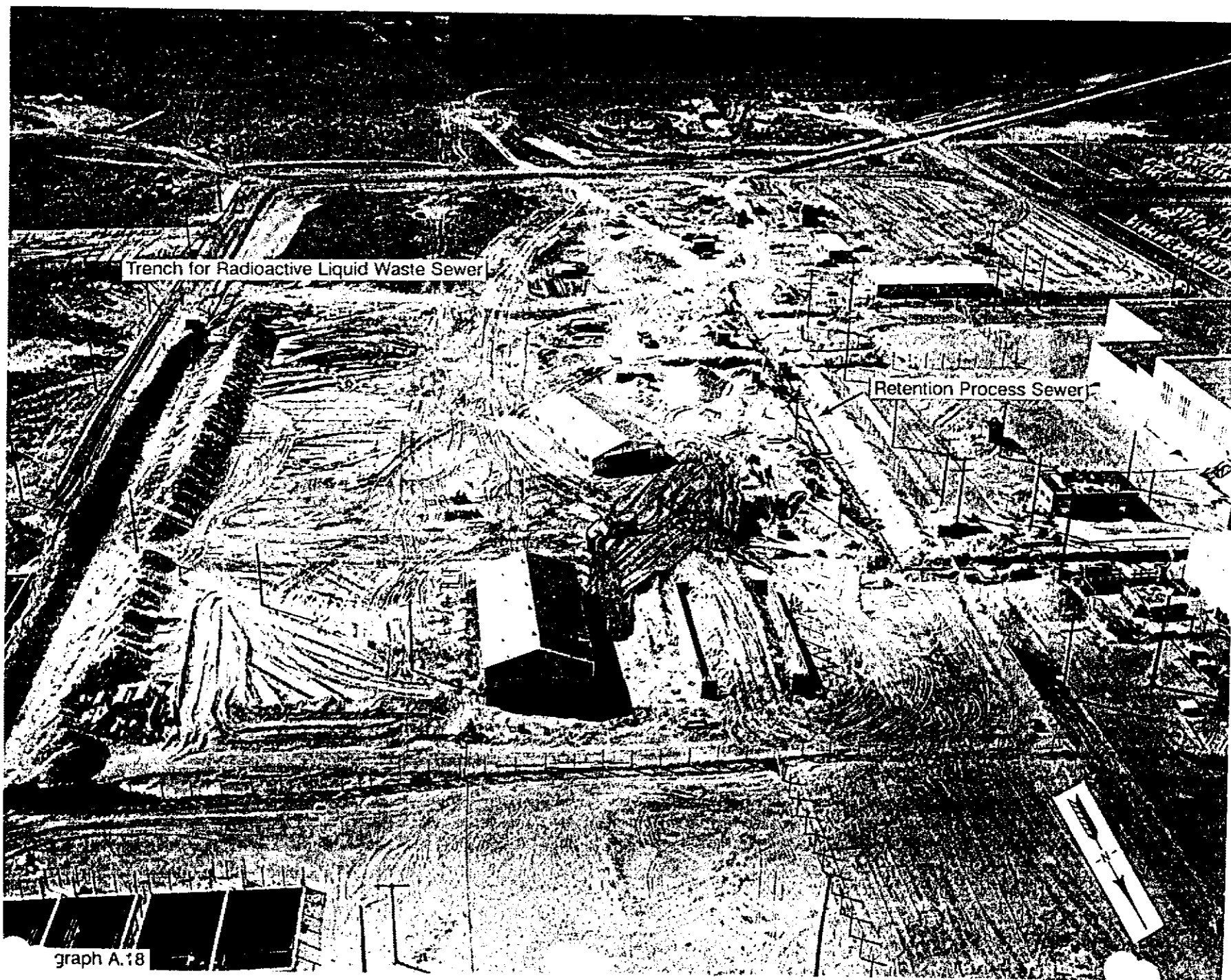
A.33

PHOTOGRAPH A.17. May 15, 1956. Burial Ground 3 is still in use. Burial Ground 4 (316-4) is being used. A new trench appears to have been installed just south of the burn cage. A drag line is scraping the bottom of the North Process Pond (Negative No. 3747).



A.35

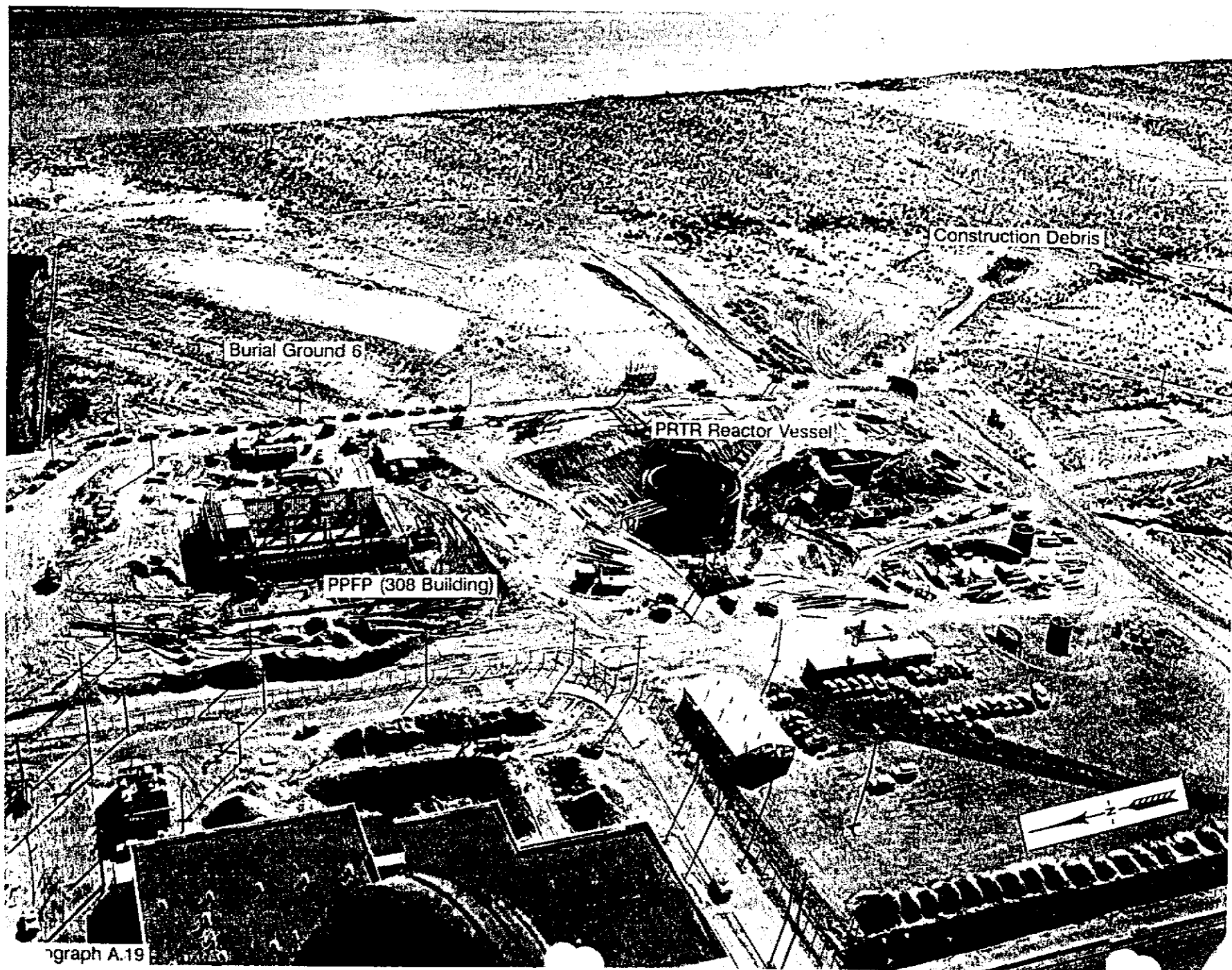
PHOTOGRAPH A.18. April 29, 1958. The site is being prepared for the construction of the PFPP (308 Building) and the 309/PRTR Buildings. The trench being excavated on the left is for the Radioactive Liquid Waste Sewer Line (now abandoned) from the 309/PRTR. The pipe being laid in the trench left of center is the Retention Process Sewer for the 308 Building. The prefabricated structures being moved onto the foundations are the 3718 A and B Buildings (Negative No. 5146).



graph A.18

A.37

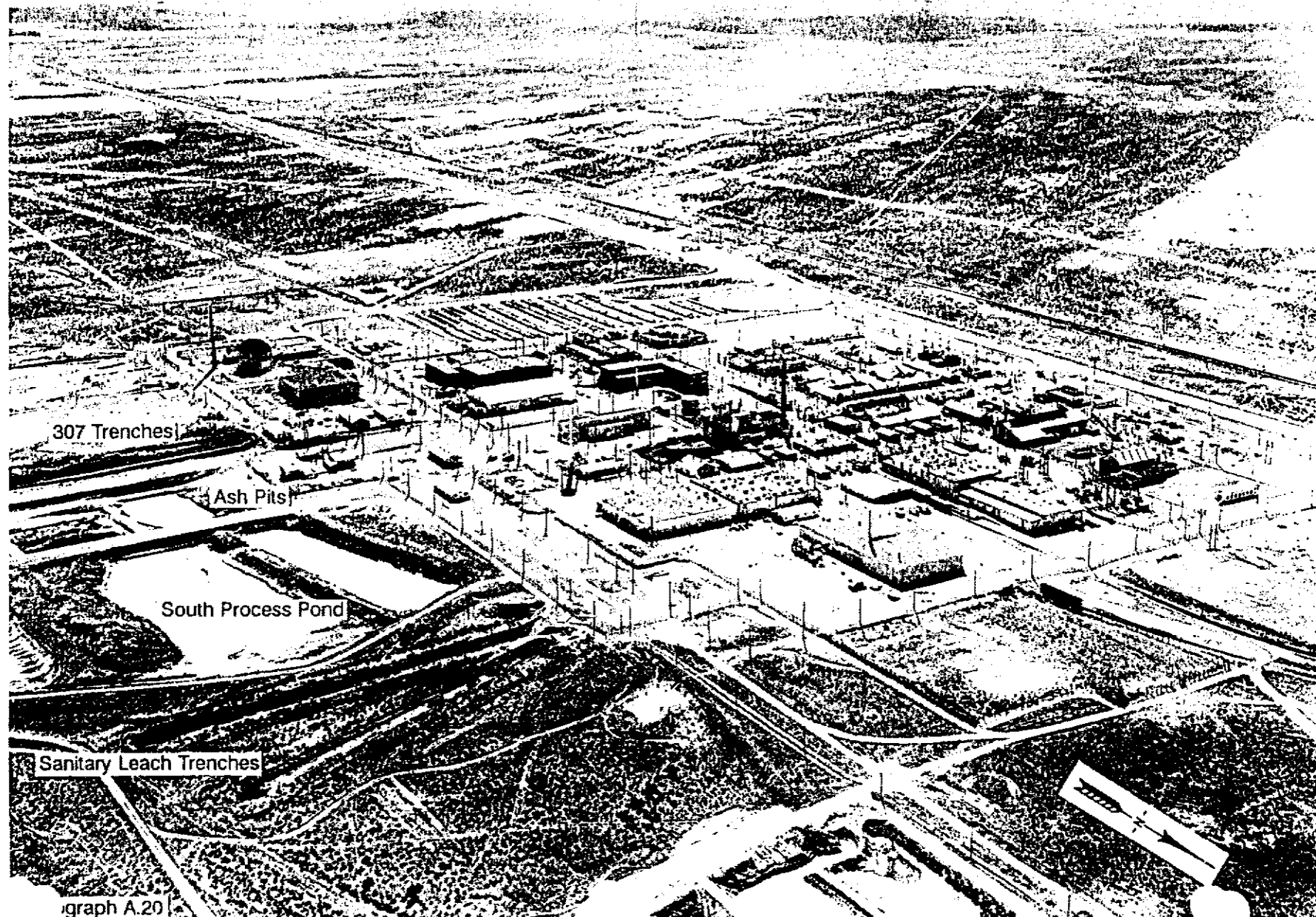
PHOTOGRAPH A.19. September 30, 1958. Under construction are the PRTR reactor vessel and the PFPP (308 Building). In the upper right portion of the photograph is a burial pit for construction debris. This pit contains no radioactive material. The fenced area east of the PFPP is Burial Ground 6 (Negative No. 5342).



Graph A.19

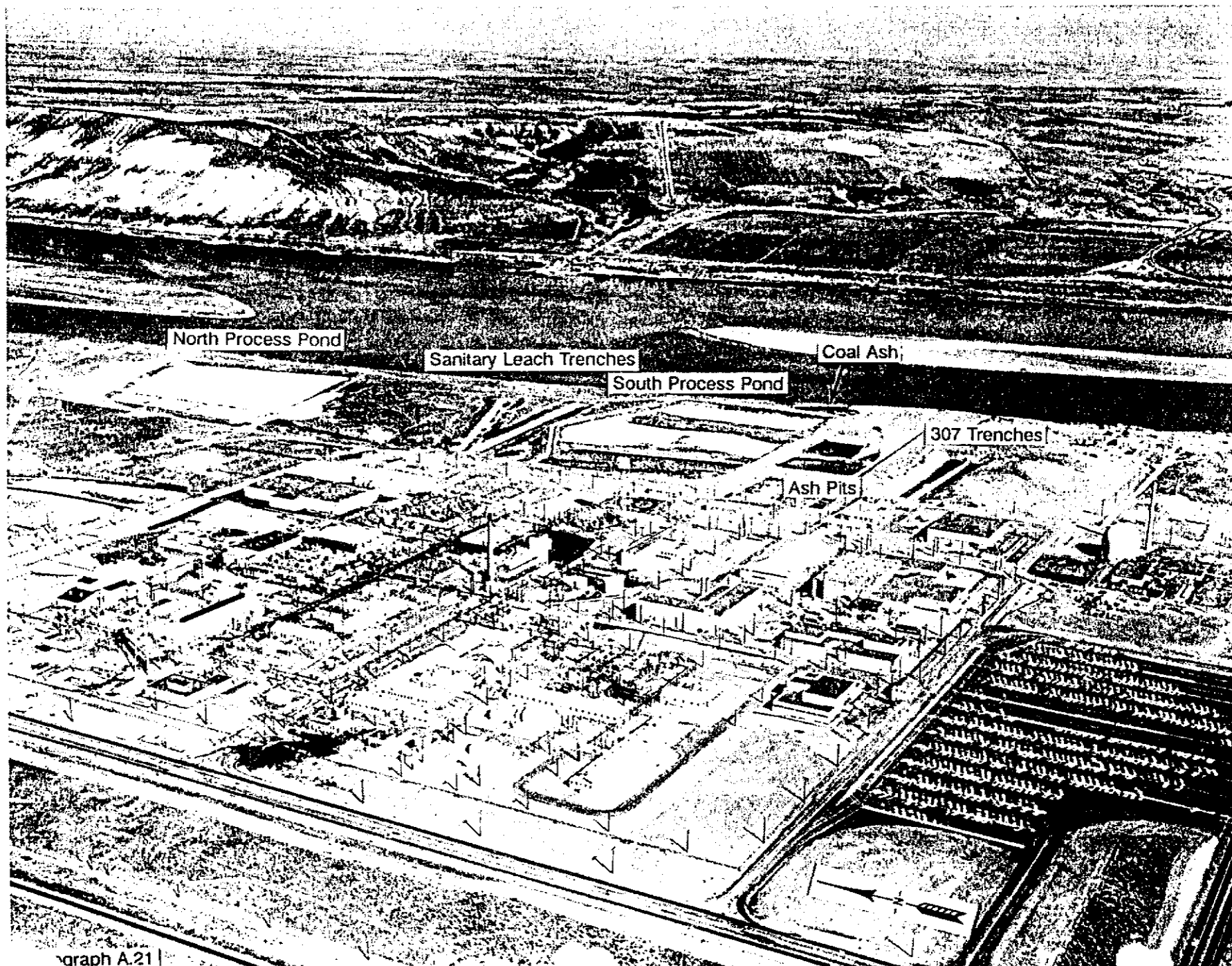
A.39

PHOTOGRAPH A.20. May 1, 1962. The South Process Pond and 307 Trenches can be seen in the left side of the photograph. The ponds have been partitioned with dikes. The ash trench has been replaced with two ash pits (Negative No. 6448-3).



A.41

PHOTOGRAPH A.21. May 1, 1962. Across the center of the photograph are the North Process Pond, the Sanitary Leach Trenches, the South Process Pond, the ash pits which replaced the ash trench, and the 307 Trenches. Pond scrapings are being piled on the south side of the north pond in what is later called the scrapings disposal area. Coal ash has been bulldozed from the ash pits to the shore of the river (Negative No. 6448-2).



graph A.21

A.43

PHOTOGRAPH A.22. June 1962. The North Process Pond has been divided into three additional settling basins. Just north of the septic tank and the Sanitary Leach Trenches is a newly excavated pit for burning debris (Negative No. 29033).



PHOTOGRAPH A.23. 1962. This photograph shows many of the 300 Area waste sites active in 1962, including the 307 trenches, the Sanitary Leach Trenches, the ash pits, the process ponds, Burial Grounds 4 and 5, the 309 construction waste pit, the new burn pit, and burial grounds west of the 300 Area. Prior to the 1970s, fresh water was supplied to the 300 Area from the city of Richland. On the left side of the photograph are three ground scars from the water pipelines. The scar marked "A" is from an early 6-inch line, at one time called the "civil defense line." The scar marked "B" is from a 12- to 14-inch line, and "C" is from a 16-inch line. After the PRTR was placed in layaway, the Filtered Water Plant (315 Building), which supplied the PRTR with water from the Columbia River, became the pumping station for freshwater for the 300 Area (Negative No. 9619).



Photograph A

A.47

PHOTOGRAPH A.24. December 1963. The depression in the right of the photograph is the 307 Trenches after they were decommissioned and excavated. The new construction in this photograph is the 324 Building (Negative No. 34631-3).



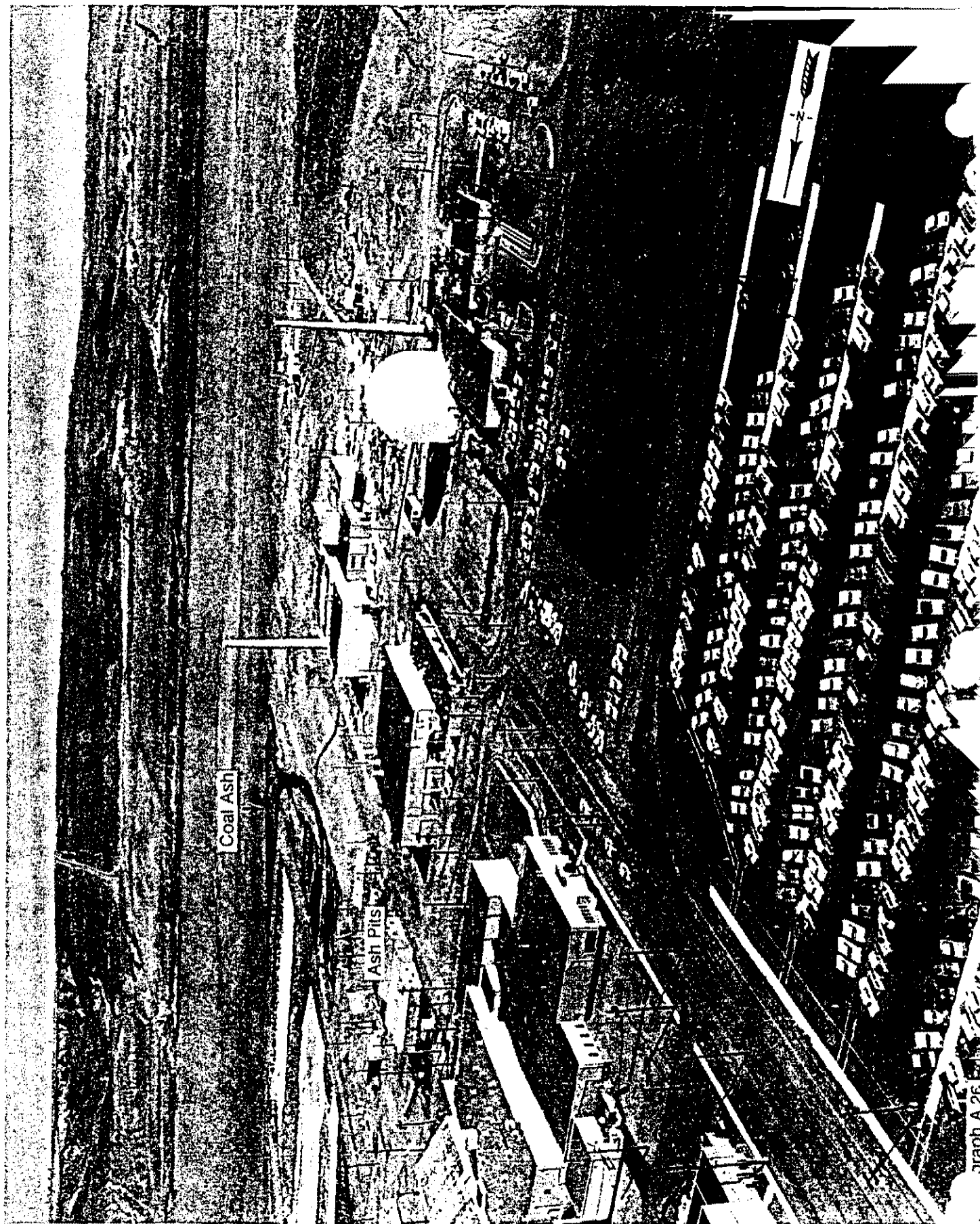
Graph A.24

PHOTOGRAPH A.25. 1964. The 307 Trenches are gone, but the 309/PRTR burial pit and the burn pit north of the septic tank still exist. Scrapings from the process ponds can be seen in the scrapings disposal area on the south side of 316-2 (Negative No. 90061562.3).



A.5.1

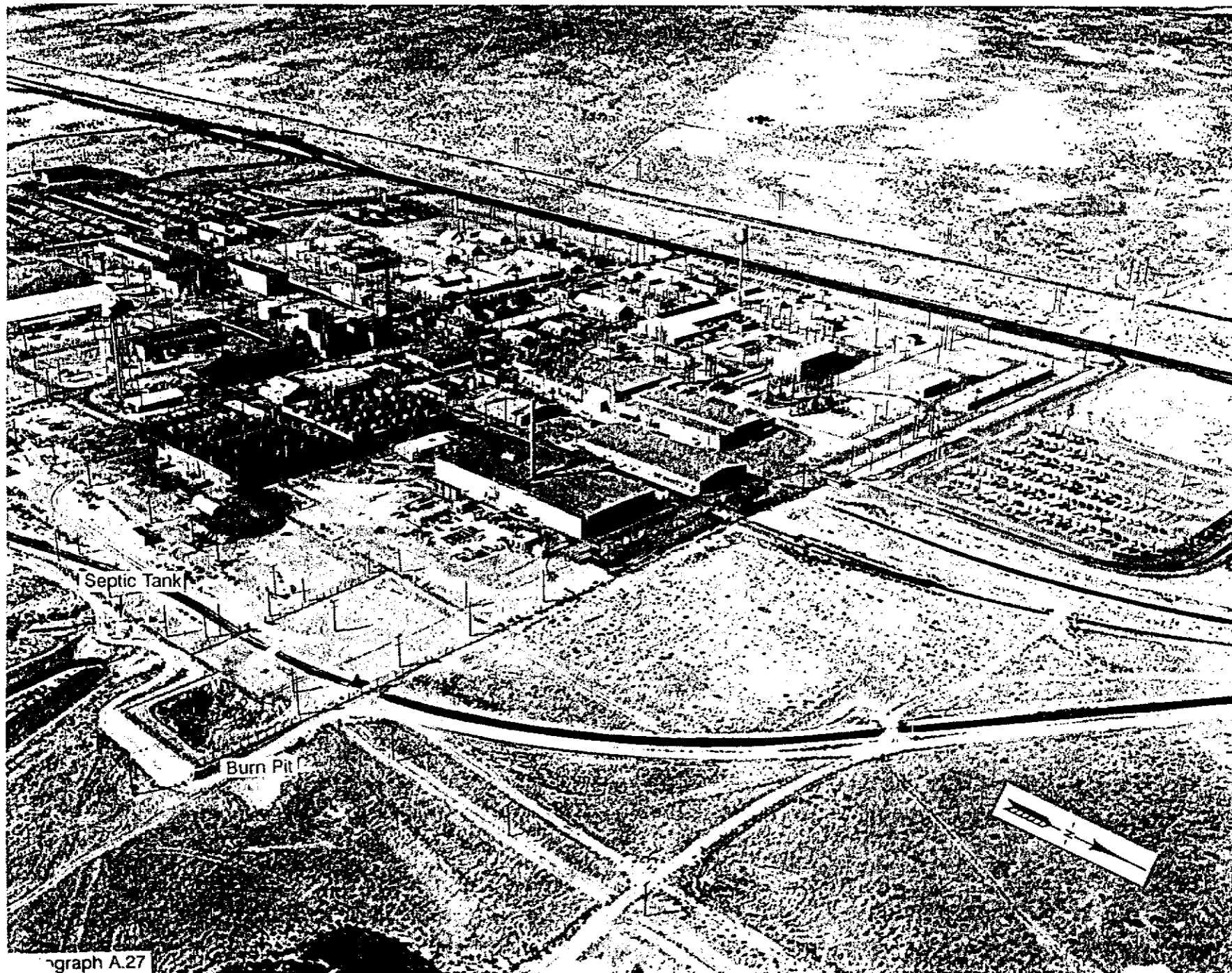
PHOTOGRAPH A.26. February 17, 1965. Coal ash from the ash pits is being bulldozed to the edge of the Columbia River (Negative No. 38706-53CN).



Graph A.26

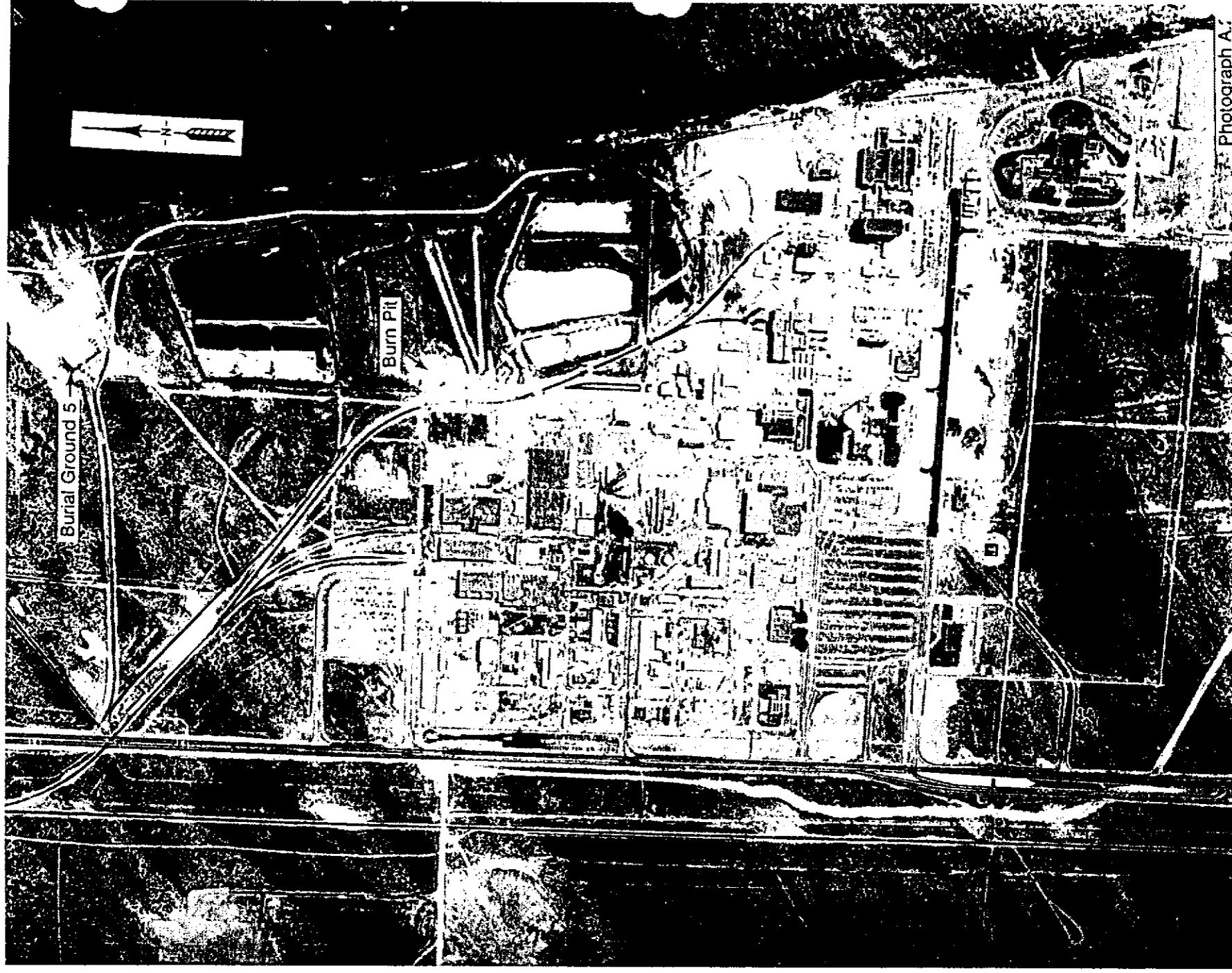
A.53

PHOTOGRAPH A.27. August 5, 1969. The septic tank and the nearby burn pit are in the lower left of this photograph. This pit was used alternately with Burial Ground 5 from 1962 until 1974, when all burning was discontinued (Negative No. 50346-2).



Graph A.27

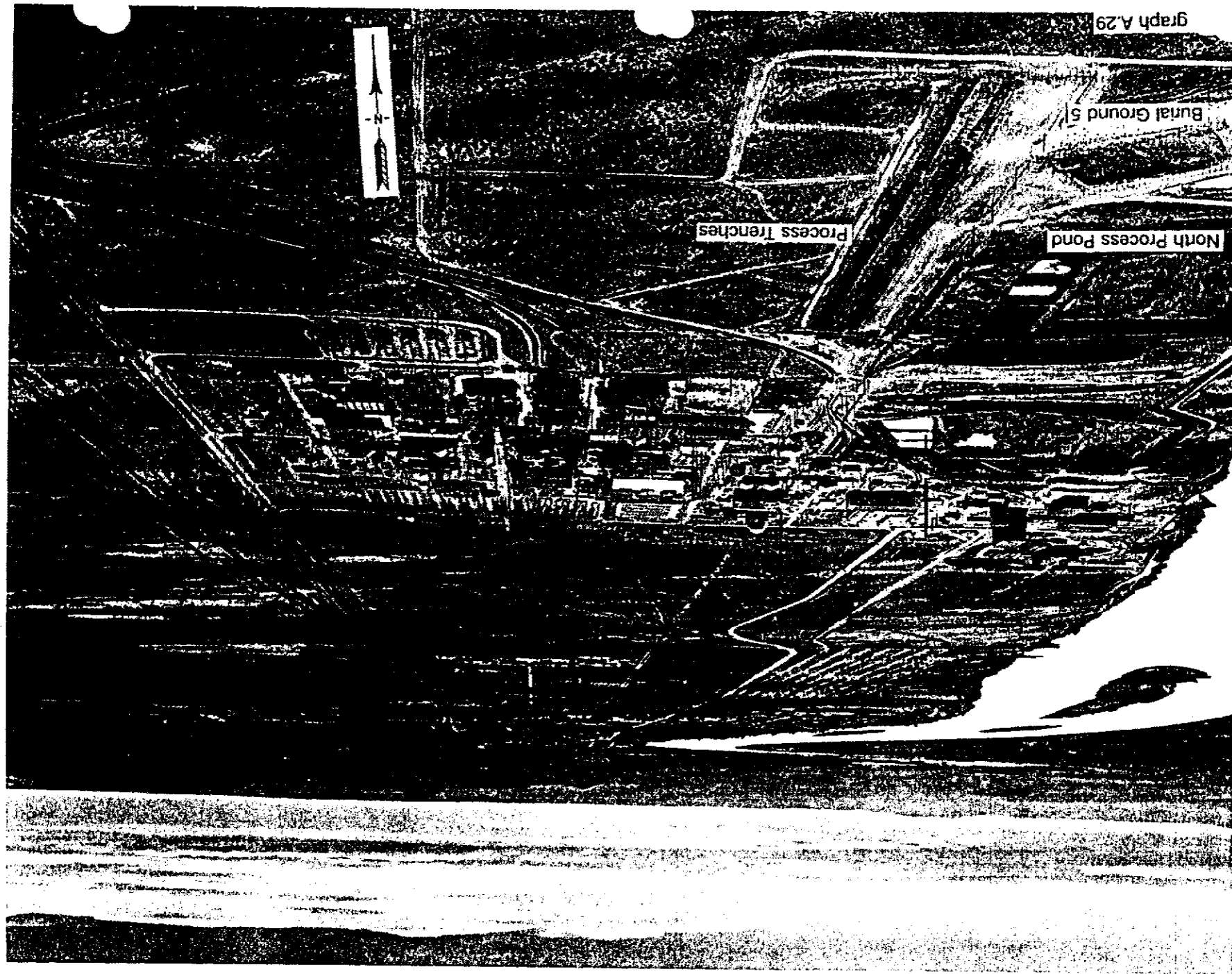
PHOTOGRAPH A.28. May 7, 1974. Both burning grounds have been placed out of service and filled (Negative No. 63655-10).



Photograph A.

A.57

PHOTOGRAPH A.29. February 4, 1975. The Process Trenches (316-5) in the foreground, which are to take the place of the process ponds, have been dug but are not in use. Burial Ground 5 is at the lower left corner of the photograph. In the first three impoundments of the North Process Pond are mounds of pond scrapings that contain sodium aluminate, copper, uranium, and other contaminants (Negative No. 67334-5).



Graph A.29

Burial Ground 5

North Process Pond

Process Trenches

PHOTOGRAPH A.30. March 23, 1978. Burial Ground 5 is in the center of the photograph. The site was surveyed with a metal detector, and the white lines indicate areas where metal objects are buried. One of the Process Trenches is full of liquid waste (Negative No. 7803021-4).

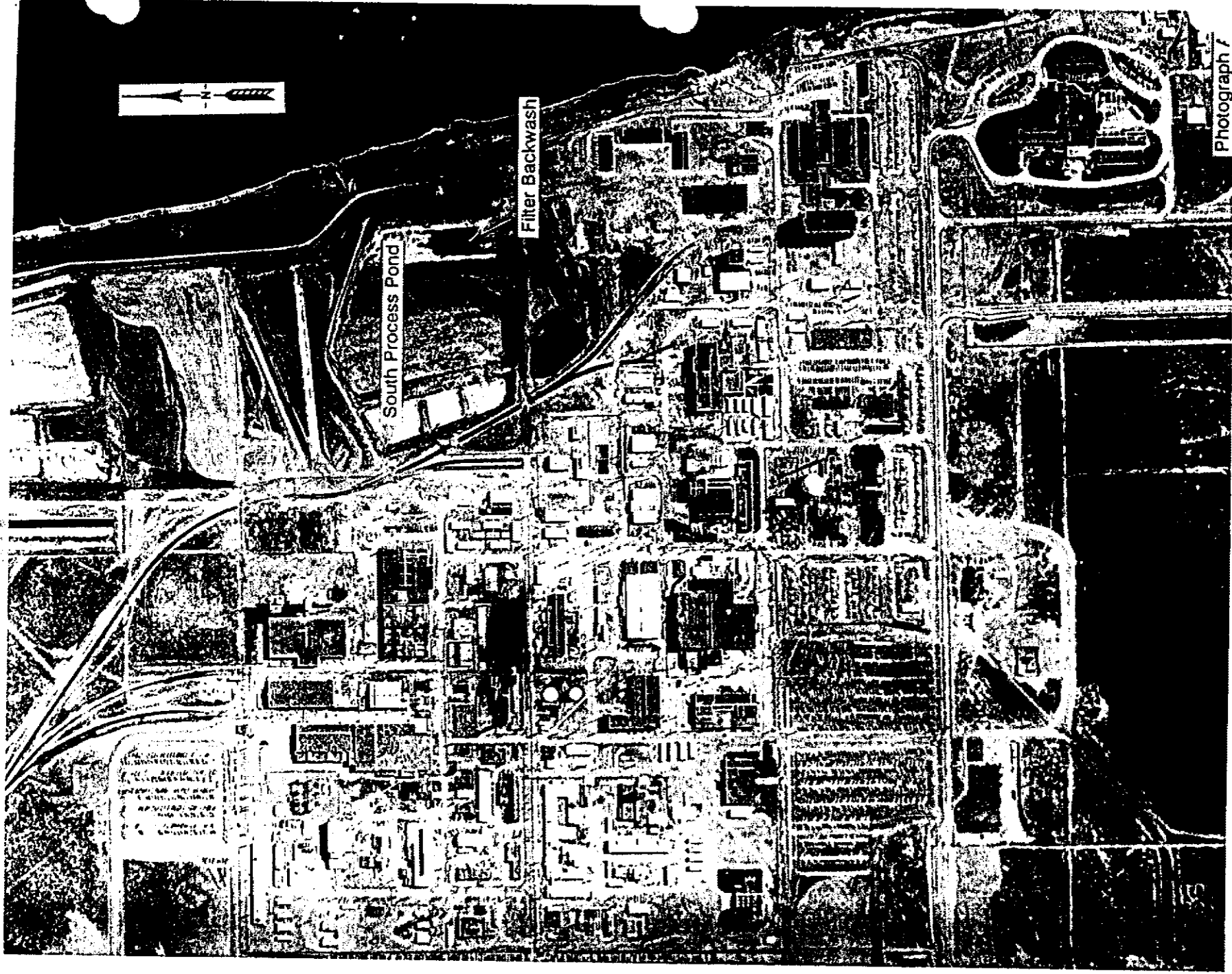


Photograph A.30

A.61

- PHOTOGRAPH A.31. September 1975. The scar on the river bank, indicated by the arrow on the right side of the photograph, is the channel cut by the October 1948 break in the dike of the South Process Pond, when 14.5 million gallons of process waste water were discharged to the Columbia River (Negative No. 69880-16).

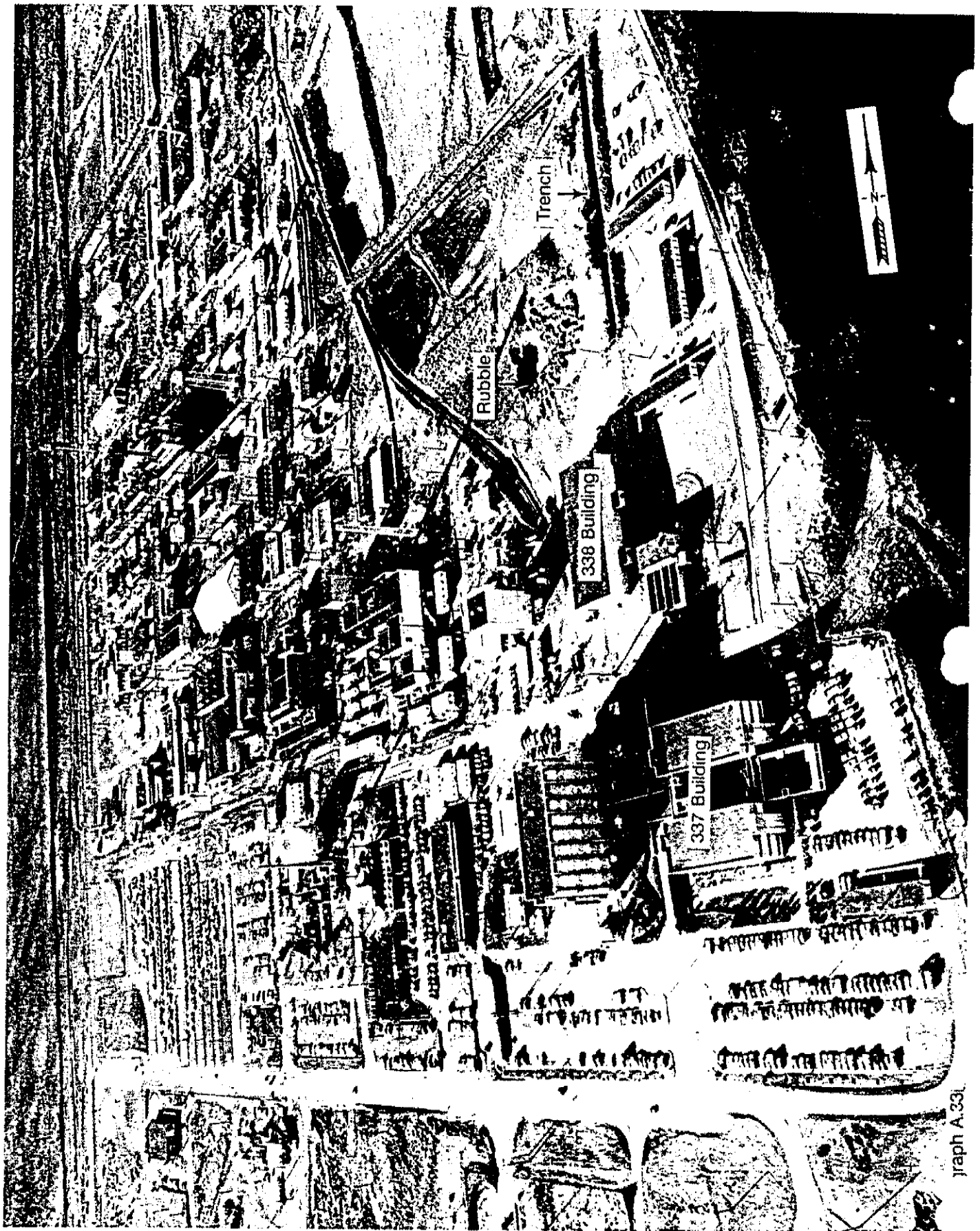
PHOTOGRAPH A.32. March 20, 1978. The east impoundment of the South Process Pond, in the lower portion of the photograph, is being used to contain filter backwash water from the Filtered Water Plant. The backwash originally went to the Columbia River but was redirected in 1976. (Negative No. 81711-35).



Photograph 7

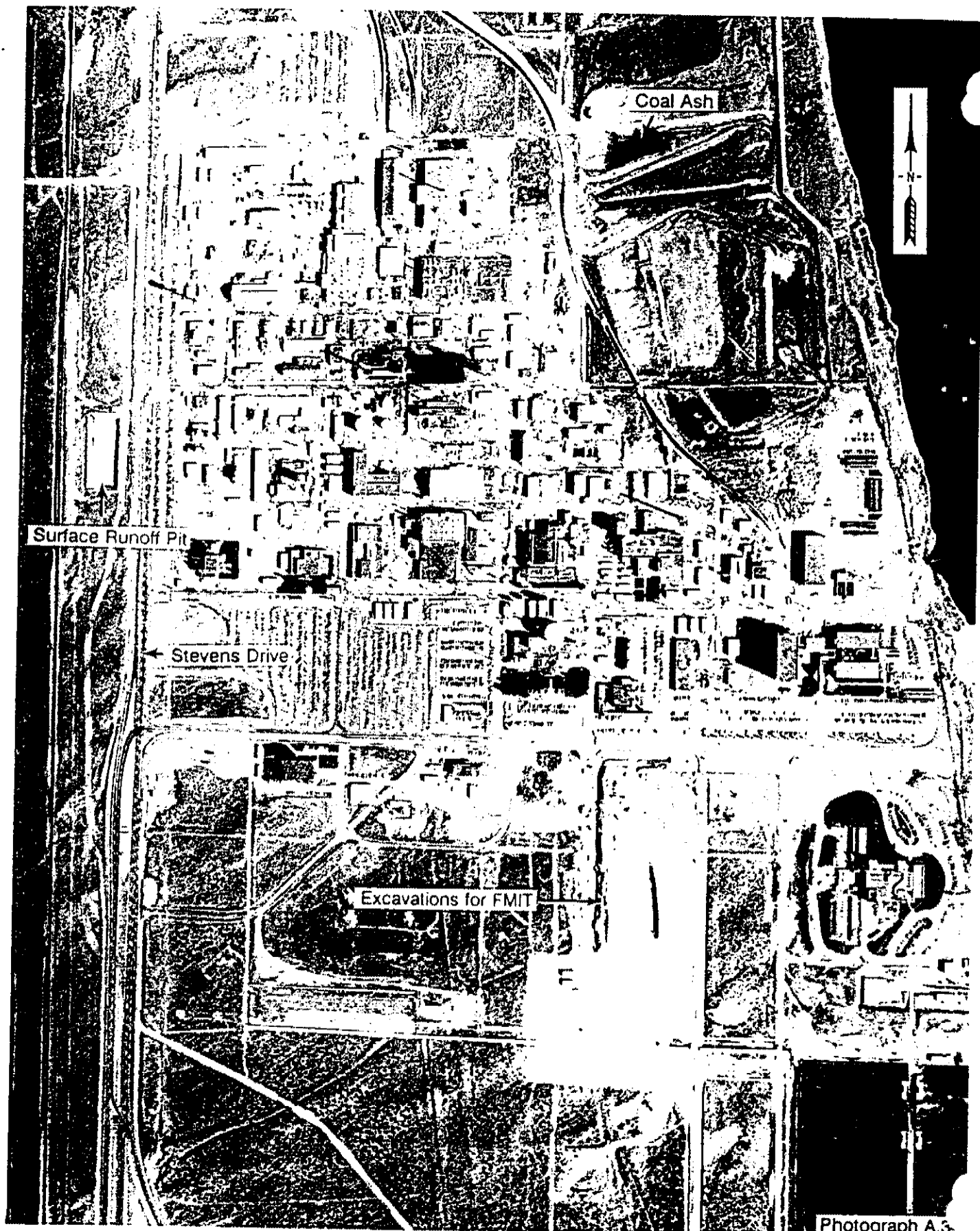
A.65

PHOTOGRAPH A.33. March 2, 1979. The depression left from the excavation of fill dirt for the 337 and 338 Buildings was used for the dumping of concrete and other construction rubble. Mounds of rubble from dump trucks can be seen to the right of the 338 Building. The rubble was eventually smoothed over, and today there is a single large mound at that location. The trench is for a new 12-inch sanitary water line (Negative No. 85668-11).



Graph A.331

PHOTOGRAPH A.34. September 8, 1980. The dark patch just north of the Sanitary Leach Trenches is coal fly ash taken from the ash pits. During the 1980s, ash was spread over much of the area between the process ponds. The newly dug trench and pit are for electrical lines and the basement of the Fusion Materials Irradiation Test (FMIT) facility, which was never completed. The rectangular pit across Stevens Drive at the top of the photograph was for surface-water runoff from the 300 Area west parking lot. (Negative No. 092782-6).

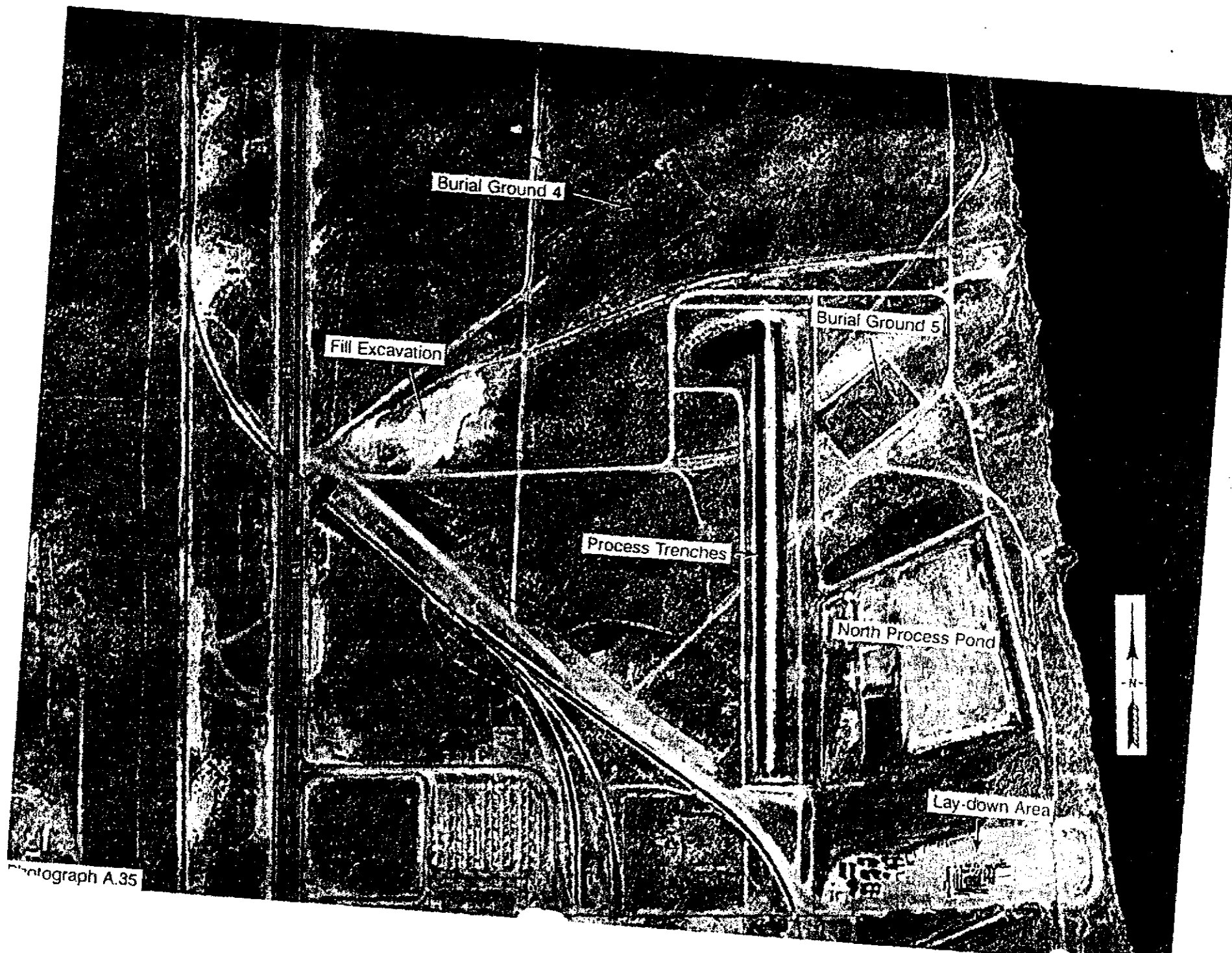


Photograph A.3.

A.69

PHOTOGRAPH A.35. July 22, 1986. This photograph includes the northern portion of 300-FF-1. The objects on the lay-down area south of the North Process Pond are equipment from the Clinch River Breeder Reactor. The lay-down area is covered with gravel. The barren sandy area southwest of Burial Ground 4 has been excavated for fill sand (Negative No. 8605019-5CN).

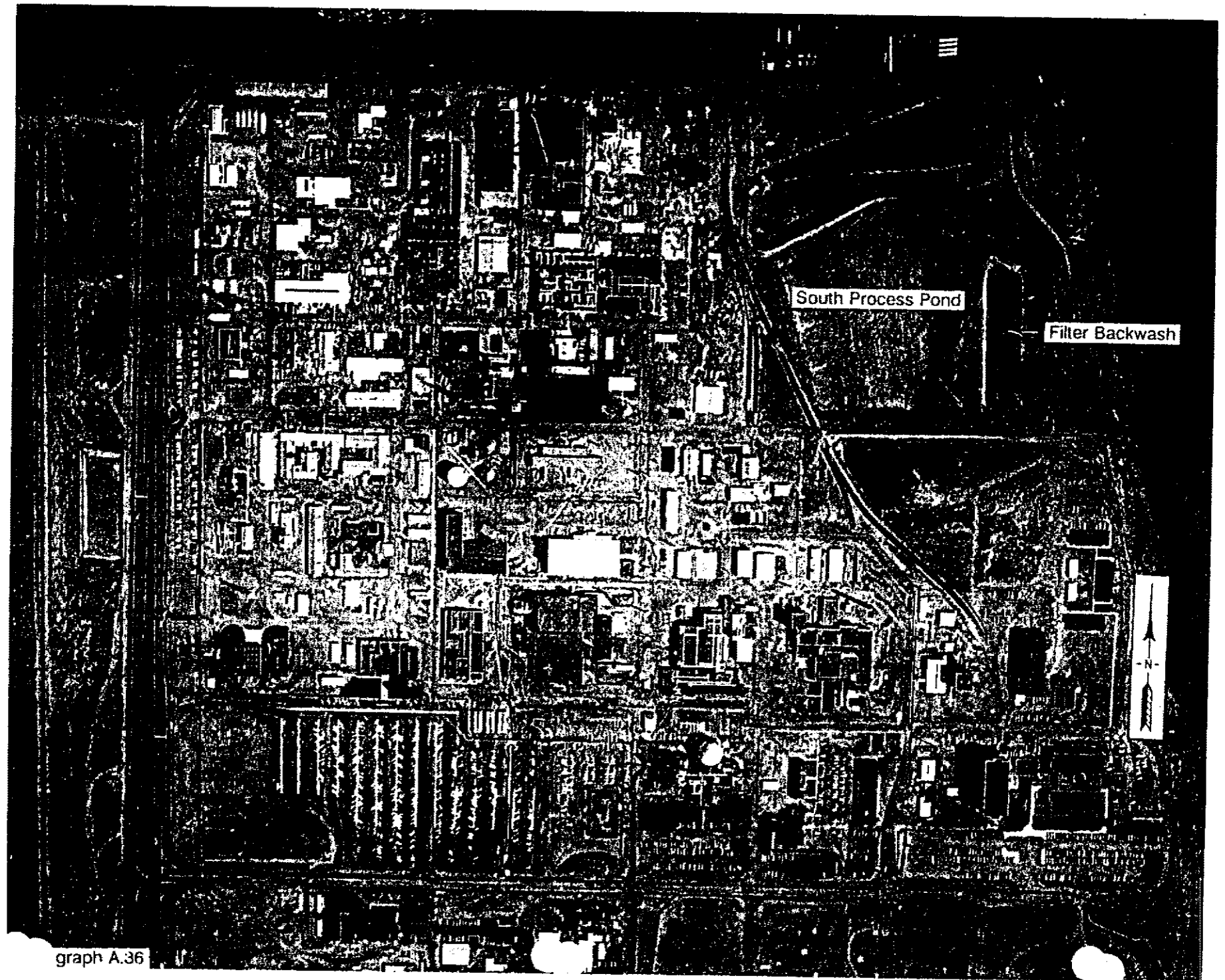
A.70



Photograph A.35

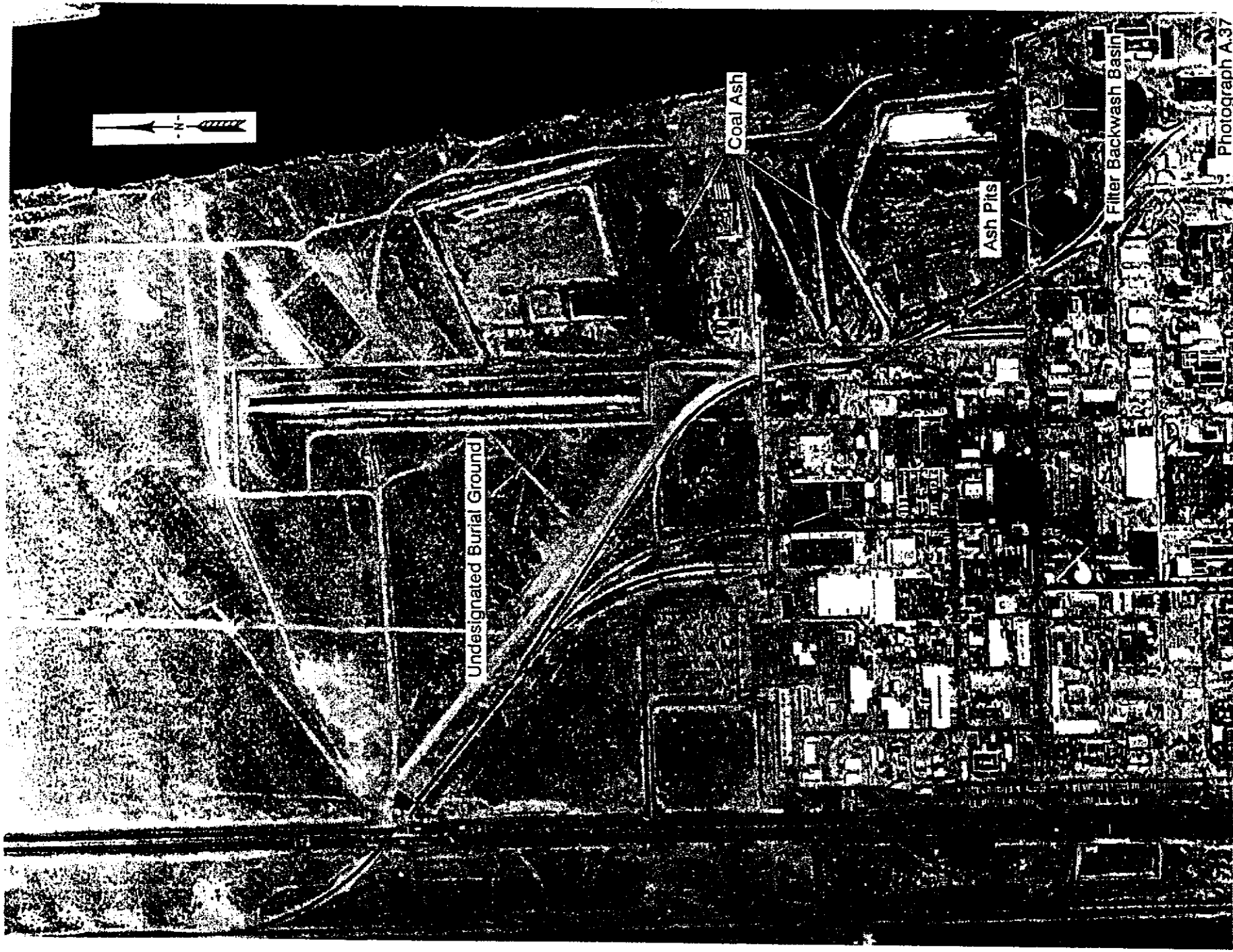
A.71

PHOTOGRAPH A.36. July 22, 1986. This photograph includes the southern portion of 300-FF-1. The eastern impoundment of the South Process Pond is still being used for filter backwash (Negative No. 8605019-9CN).



graph A.36

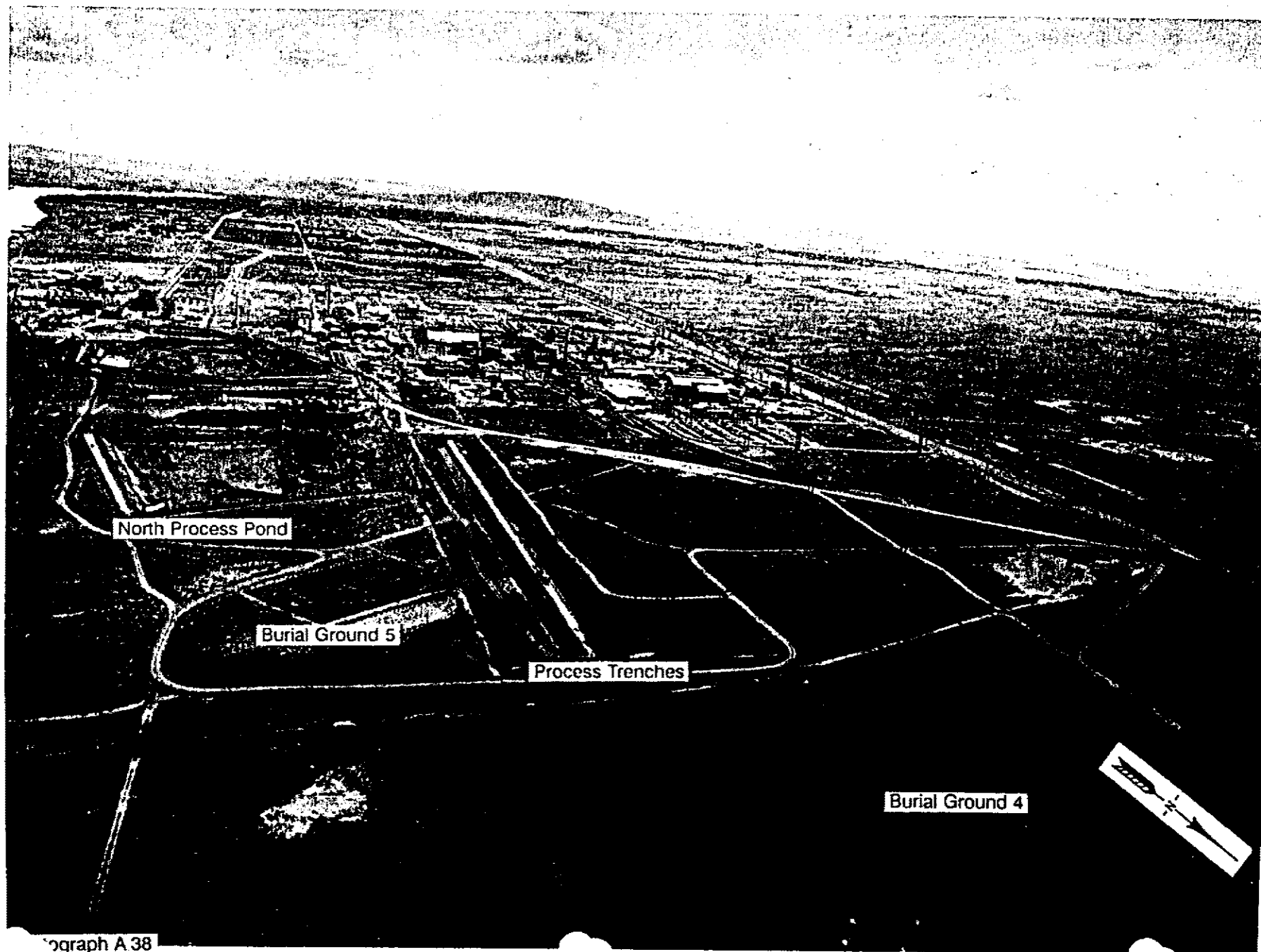
PHOTOGRAPH A.37. May 1987. This infrared photograph includes most of 300-FF-1. Filter backwash is now discharged into a new basin, in the lower left portion of the figure next to the ash pits, instead of to the South Process Pond. The dark areas between the two ponds are coal ash excavated from the ash pits and trucked there for disposal. The ash is several feet deep in places. The outline of an undesignated burial ground can be seen near the Process Trenches (Negative No. 5676-149).



Photograph A.37

A.75

PHOTOGRAPH A.38. May 19, 1987. The Process Trenches and Burial Grounds 4 and 5 are in the foreground. The holes being dug in the North Process Pond are for sediment sampling. Radiological and chemical analysis of the samples were reported in Dennison et al. (1989) (Negative No. 8703018-55CN).

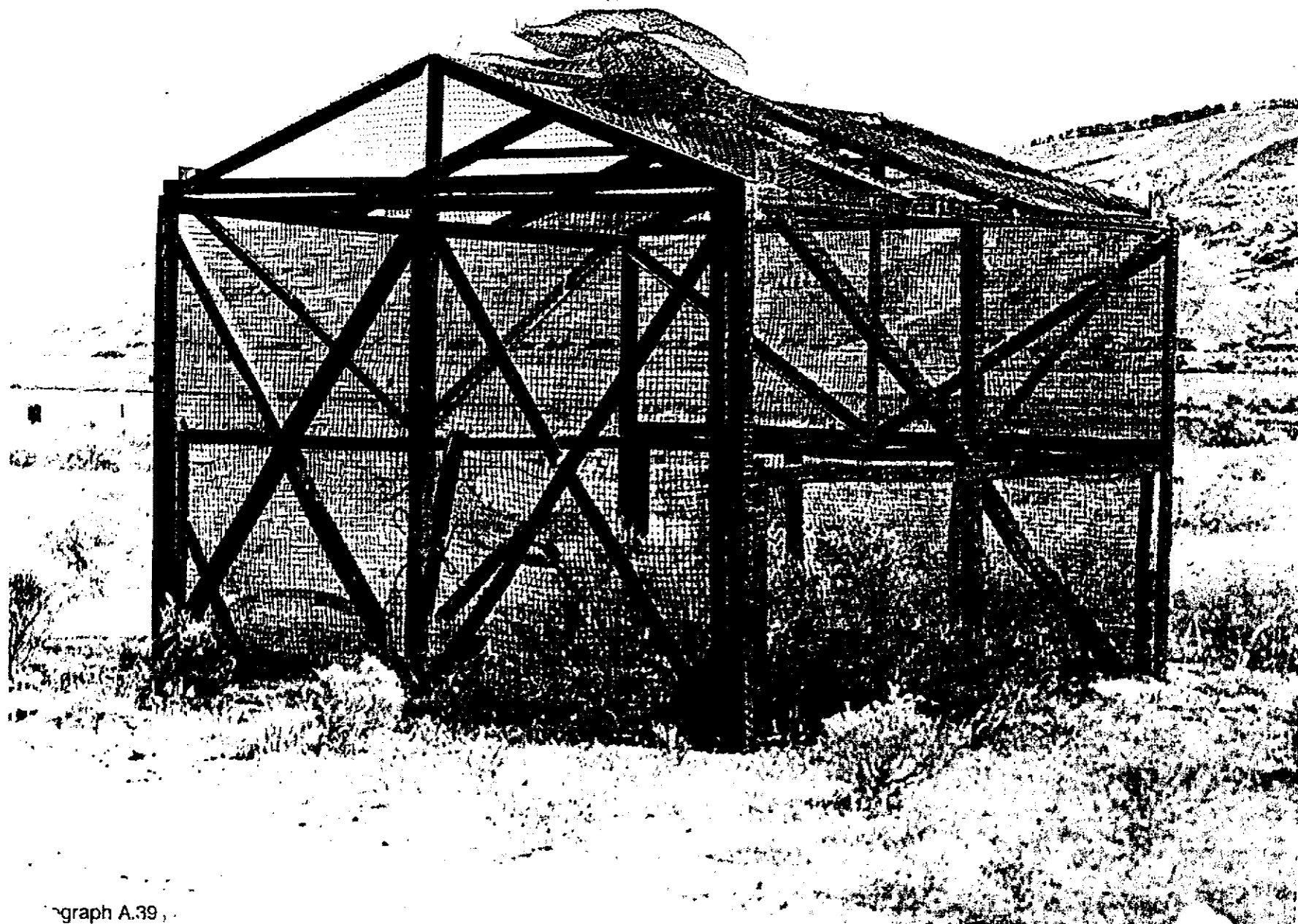


Photograph A 38

A.77

PHOTOGRAPH A.39. July 3, 1990. A wire mesh burn cage, just east of Burial Ground 4 and near the Columbia River, was used from the late 1940s for the incineration of paper trash (Negative No. 90091801-5CN).

A.78



Graph A.39

A.79

PHOTOGRAPH A.40. July 3, 1990. A steel drum and a laboratory bottle are part of the debris found near the Columbia River around the burn cage. A recent radiation surface survey has revealed that some of this debris is radioactive (Negative No. 90091801-12CN).

A.80

Photograph A.



APPENDIX B

300 AREA BUILDINGS AND FACILITIES

APPENDIX B

300 AREA BUILDINGS AND FACILITIES

The first buildings in the 300 Area were mainly involved with the fabrication of uranium fuel, though some pilot-scale research and development work was conducted in the 321 Building for the REDOX and PUREX Plants. In the early 1950s the Works Laboratories were constructed for a variety of weapons and peaceful research and development activities. In the late 1950s, the Plutonium Recycle Test Reactor (PRTR) and the Plutonium Fuels Pilot Plant (PFPP) were built for developing peaceful uses of plutonium.

The following buildings and facilities have been important in fabricating fuel or research and development. Also listed are facilities that collected or treated wastes. The information was extracted from the AEC-GE Study Group (1964) and interviews. The date listed after the facility name indicates when the building went into service. The buildings may have functions different today from what is described here, and many lie outside 300-FF-1, but most, at some time, contributed to the 300 Area waste stream that entered 300-FF-1.

303-A, 303-B, 303-C, 303-E, and 303-G Product Storage Buildings (1944) - These buildings stored equipment, bare uranium cores, fuel elements, and uranium billets.

303-F Chemical Storage and Dispersal Building (1944) - This building was used for chemical storage and chemical make-up for aluminum cleaning in the 313 Building. It also served as a pumphouse for sodium hydroxide, nitric acid, degreaser solvents, and neutralized waste solutions. 303-F
313

303-K Decontamination and Battery Charge Building (1944).

303-L Uranium Scrap Calcination Building (1961) - This building provided facilities for burning uranium chips and fines until 1971. It was removed in approximately 1976.

303-M Uranium Oxide Facility (1983) - This facility was used for calcination of uranium chips and fines.

304 Uranium Scrap Concentration Storage (1952) - This facility was used originally as a fuels pilot plant and in 1972 to encapsulate uranium chips with concrete.

305 Test Reactor and Hot Cell Verification Facility (1944) - Until 1971 this facility contained a low-power reactor used to perform nuclear purity tests on graphite and reactivity control tests on bare and canned uranium cores. The reactor provided neutron irradiation for technical and instrument development work. In addition, tests were made on any materials used in the nuclear industry. From 1967 to early 1978 it was used for casting and machining copper-silicon preshapes for the N-Reactor fuel process. It was a hot cell verification facility after 1978.

305-B Physics Test Reactor Building - This building contained two reactors for determining physics constants of various reactor concepts. The Zero Power Constants Testing Reactor had a flexible core that could be loaded to duplicate different reactor arrangements. A smaller, more sensitive thermal test reactor had a low-flux thermal column. The building also had a critical approach tank.

306-E and 306-W Metal Fabrication Development Laboratory or Metallurgical Semi-Works (1956) - Although designed for metallic reactor fuel element development, the buildings had more general use for metallurgical research and development and pilot operations because of the utility grids and a variety of metallurgical equipment. Originally the 306 Building, it was expanded to twice its size around 1960, and was designated as 306-E and 306-W in 1972.

308 Plutonium Fuels Pilot Plant (1960) - This plant contained laboratories to develop technology for the manufacture of plutonium-bearing fuels.

309 Plutonium Recycle Test Reactor (1960) - This reactor was used originally to develop technology for plutonium as a fuel in thermal heterogeneous power reactors. It was a vertical pressure tube type reactor, heavy water cooled, with a thermal rating of 70 megawatts. The reactor was placed in layaway in 1969.

311 Methanol Still House (1953) - This building contained a still to dehydrate methanol for cleaning processes in the 313 Building, and was used until late 1971. Associated with the 311 building were two underground storage tanks. The tanks and the buildings were removed in 1989. 311/
313

313 Fuels Manufacturing Building (1944) - This building was originally designed for fuel and target element preparation for single-pass production reactors. Later it was used for chemical recovery of uranium in acid solution and neutralization of waste acid received from all fuels facilities. The building was also used for billet and component storage as well as an engineering development laboratory.

314 Engineering Development Laboratory (1944) - This building was used until 1952 for reducing uranium fluoride to uranium metal, casting and machining uranium ingots, straightening uranium rods, remelting uranium scrap, and salt-bath heat testing uranium cores. From 1952 to 1965 it was used for development work in fuels production and, since 1965, as a research facility.

315 Filtered Water Plant (1960) - This plant filtered raw water from the Columbia River to supply the PRTR reservoir and rupture loop. Its process sewer drained wastewater directly to the river from the sedimentation basin drains and overflows, the filter overflow and drain, the filter backwash, the clearwell overflow, the service area equipment drains, and the floor drains. The sanitary sewer from the building fed a septic tank and 50-ft-long tile drain field. It is now used to supply fresh water to the entire 300 Area complex.

321 Cold Chemical Semi-Works, later the Engineering Development Laboratory, now the Hydromechanical Building (1944) - Originally this building was used as a chemical pilot plant (REDOX and PUREX) for the separation of isotopes and for evaluating materials and process components under controlled radiation and chemical conditions. These operations were transferred to the 324 Building. Later it was used for hydraulic and mechanical research and development of reactor components.

323 Metals Creep Laboratory (1959) - Originally it was a uranium facility. Later it was used to test facilities in support of critical FFTF/LFMBR components.

324 Chemical Engineering Laboratory (1966) - Nonradioactive and radioactive development studies are performed here from laboratory bench-scale to full engineering-scale pilot plant operations. It also houses a nuclear materials storage vault.

325 Radiochemistry Building (1953) - This building provides specially shielded, ventilated, and equipped laboratories for radiochemical and radioceramic work, including high-temperature studies.

326 Physics and Metallurgy Building, now Materials Technology Building (1953) - This building contains laboratories and facilities for studying many materials, including metallurgical, chemical, and physical behavior of reactor components and fuel elements.

327 Radiometallurgy Building (1953) - This building contains laboratories specially shielded, ventilated, and equipped for the physical and metallurgical examination of irradiated nuclear materials.

328 Engineering Management and Technical Shops, also called Mechanical and Development Building (1951) - These shops provide the facilities to fabricate specialized intricate apparatus and equipment required by research and development.

329 Biophysics Laboratory (1952) - Instruments used primarily for radiation detection are developed here. This building includes low-level radiation laboratories and chemistry laboratories for the study of isotopes and other contaminants in the environment.

331 Life Sciences Laboratory (1971) - A wide variety of biological and ecological research is performed here, including studies in radiation biology on large and small animals.

333N-Fuels Manufacturing Building, also called the Coextrusion Shop or Fuel Cladding Facility (1961) - Coextruded fuel elements were fabricated here for the N-Reactor.

334 Chemical Handling Facility (1961) - This facility contains liquid-level indicating instrumentation for four adjacent 6000-gallon chemical storage tanks. The chemicals were used in the 333 Building processes. The facility was also used to sample and monitor the pH of process sewers from the 313 and 333 Buildings. 334 333

334A Waste Storage Acid Building (1973) - Waste acids from the 333 Building with nonrecoverable uranium were drained into two storage tanks before being pumped into the 313 Building for neutralization. ✓

340 Retention and Neutralization Complex (1953) - This complex is used for temporary storage and neutralization of radioactive waste from the laboratories. The waste is transported to the 200 Areas for disposal. Waste was transported by semi-truck tankers until 1966 when they were replaced by railroad tank cars. This facility incorporates the 307 Retention Basins.

3706 Information Services Building, originally the Radiochemistry Laboratory (1944) - The building was the original radiochemistry laboratory that provided analytical control, control standards, and development procedures for the fuels fabrication facilities and separation plants. This role ended for the most part in 1953 when the Works Laboratories were constructed. However, uranium laboratories that provided controls for the uranium fuels department remained in 3706 until 1965. The building is now mainly office space for a variety of services.

3712 Fuels Warehouse (1961) - Uranium fuel elements, component parts for fuel fabrication, and some uranium scrap were stored here.

3716 Metallurgical Development Laboratory (1962) - This laboratory was designed as an engineering pilot plant to develop alternate reactor fuel processes. Later it stored uranium fuel elements and equipment.

3722 Construction Shop (1944) - This is now a carpenter shop. It was used from 1965 to 1967 to fabricate lithium aluminate ceramic target elements for N-Reactor tritium production, and 1968 to 1970 to produce thoria target pellets for uranium-233 production in single-pass reactors.

3730 Gamma Irradiation Building (1950) - Originally this building was associated with uranium fuel manufacturing. Later it provided shielded

facilities for studies of irradiated graphite and shop facilities for machining and fabricating specialized graphite shapes. In the late 1960s the building was equipped with a 350,000-Ci cobalt-60 source, which was installed below ground in a pit to irradiate materials. The source leaked and contaminated the pit water, which had a continuous overflow into the Process Sewer and Process Ponds. The effluent was monitored.

3732 Process Equipment Development Laboratory (1944) - Now used for storage of materials and equipment, this building was an engineering pilot plant for fuels production in the early 1960s. From 1963 to 1970 it was used to fabricate thoria powder and pellet target elements for uranium-233 production in the single-pass reactors (the thoria pellets were made in the 3722 Building).

316-1 and 316-2 North and South Process Ponds (1943 and 1948) - Waste water from fuel fabrication and laboratory facilities was disposed to these ponds until March 1975, when they were closed.

316-3 307 Process Trenches (1952) - "Nonradioactive" retention process waste from laboratories went to these trenches until 1963.

316-5 Process Trenches (1975) - These two 1500-ft-long, 12-ft-deep trenches are used for process waste from the 300 Area facilities via the Process Sewer lines.

The Sanitary Leach Trenches (1948) - These two trenches just north of 316-1 are used for leaching sewage waste.

APPENDIX C

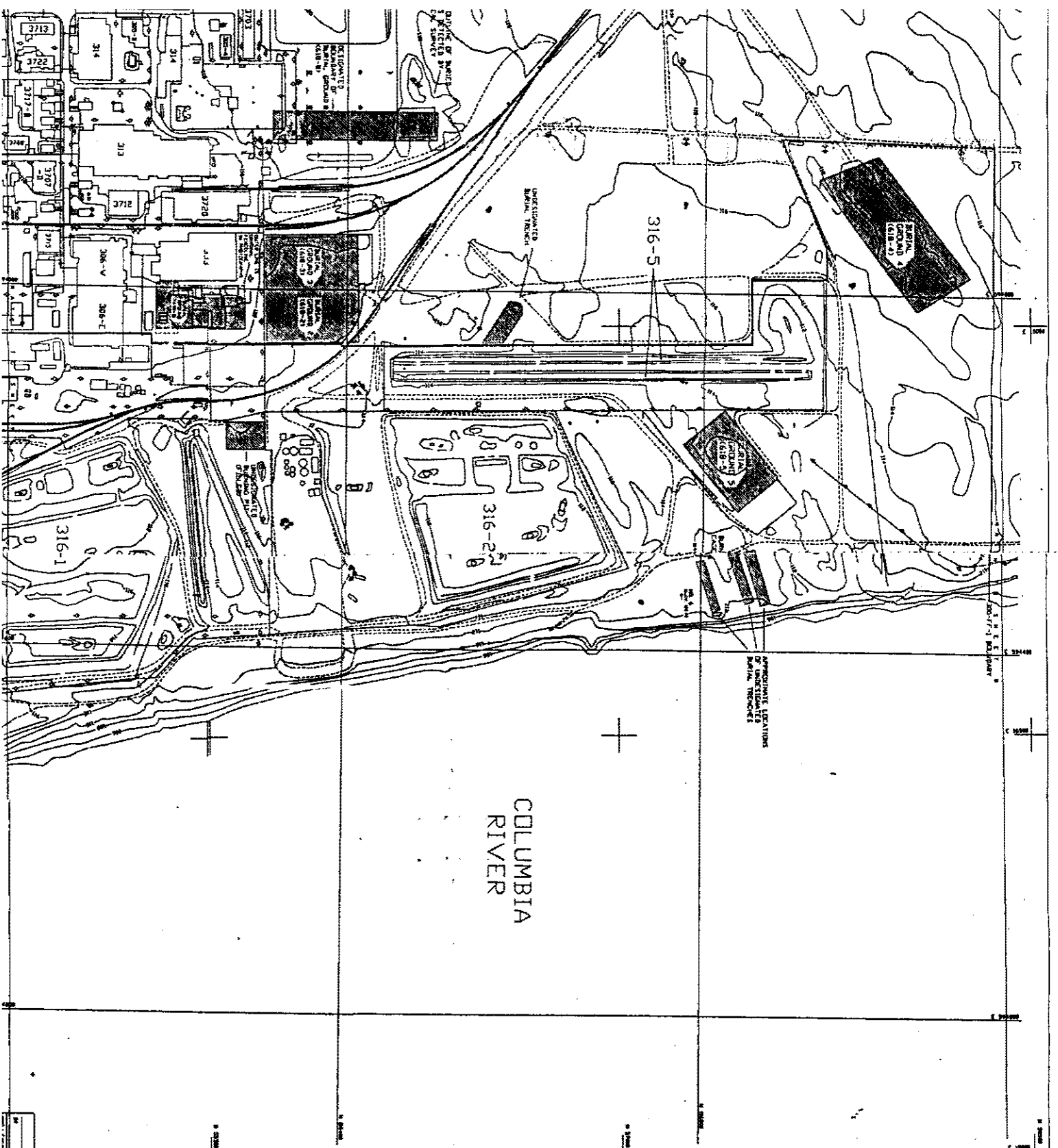
PLATES 1 AND 2

Plate 1

Topographic map of the northern portion of 300-FF-1 showing burial and burn grounds.

LEGEND

- ~ PNE HYDRANT
- TRAILS, OLD IRRIGATION LINES, ETC.
- POWER POLES
- ✱ LIGHT POLES
- BUILDINGS
- CONCRETE SLABS, WALLS, ETC.
- FENCE LINES
- POSTS & WELLS
- SOILS
- MANHOLES, PUMP WELL WATER TANKS, ETC.
- R/R TRACKS
- GRAVEL ROAD
- PAVED ROAD
- RADIO TOWER
- BURIAL AND BURN GROUNDS



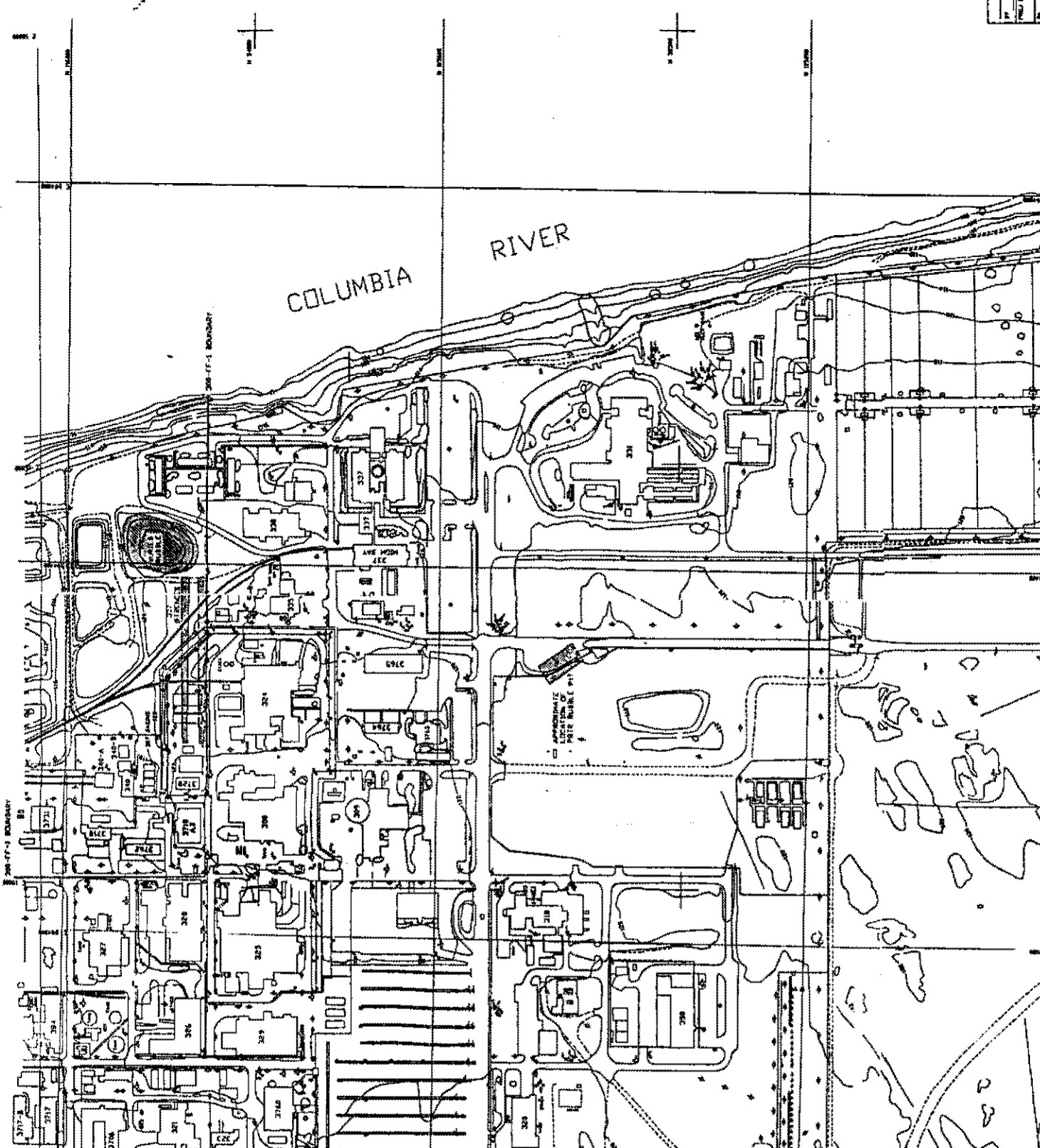


Plate 2
Topographic map of the southern portion of 300-PF-1, showing burial pits and the 307 Trenches.

LEGEND

- ⊕ FIRE HYDRANT
- ~ TRAILS, OLD IRRIGATION LINES, ETC.
- ◇ POWER POLES
- ⊛ LIGHT POLES
- BUILDINGS
- CONCRETE SLABS, VAULTS, ETC.
- FENCE LINES
- ▲ SLOPS
- MANHOLES, PURGE WELL WATER TANKS, ETC.
- ⊙ BUSHES
- ⊙ R/R TRACKS
- ⊙ GRAVEL ROAD
- ⊙ PAVED ROAD
- ⊙ RADIO TOWER
- ⊙ BURIAL GROUND AND TRENCHES

APPENDIX D

LETTER

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Classification-Declassification

August 8, 1945

TO: C.M. PATTERSON
E.M. PARKER

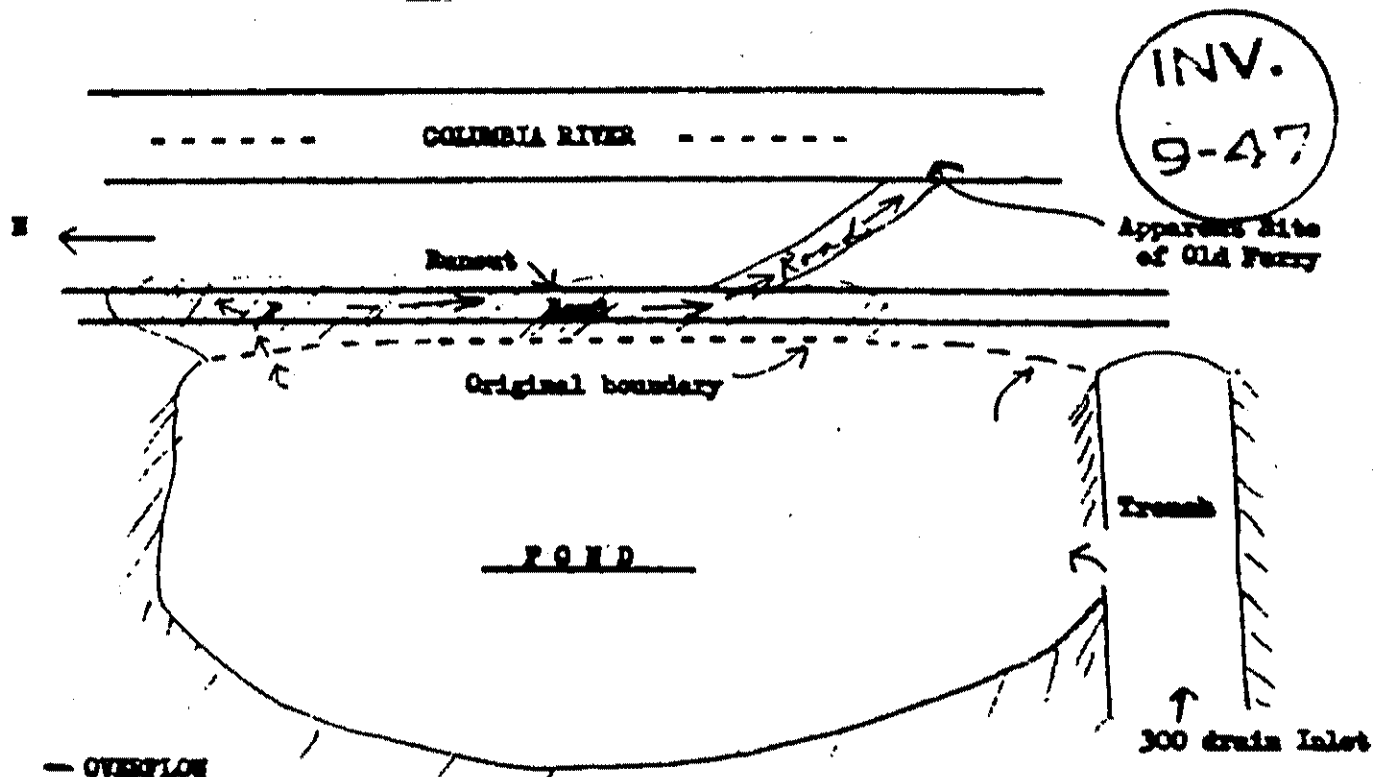
By H. R... .. Date 9-22-60

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No. 1 OF 8 COPIES SERIES A

300-AREA POND



An overflow of 300 Area Pond was reported by Site Survey and investigated by the 300 group.

DESCRIPTION

The pond is diked on three sides (N, S and W) to heights approximately 3 feet above the present water level. The East side of the pond which is towards the river is open. Up to the present time, the ground level on this side has been of sufficient height that the danger of overflow was not recognized since the sources of water for the pond were believed to be reduced.

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D.1

8/8/45

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The pond, however, has continued to rise and has broken out on the extreme NE and SE ends. A considerable area outside the original pond area is covered with about 1 inch of water. A small stream of water reached the road leading to the river edge but the water had seeped into the sand before reaching the river.

A bulldozer was sent to the area and has temporarily diked the low spots. After talking with Paul Collins, Al. Gawthrop and a member of Transportation, it was agreed to completely close in the East end of the pond (approximately 1500 ft.) with a 4 foot dike, 8 ft. deep.

It is difficult to know why the water level remains high. Much of the additional air conditioning water goes directly to sanitary sewers. Also, in checking the inlet, no excessive flow of water is noted. One possible explanation may be that the pond is "sealed", that is, ground seepage no longer is taking place and the bulk of water loss is by evaporation. This loss must be less than the inlet water.

WHD:swo

W. H. Durum
W. H. Durum, Supv. *HC*
300 Area group
H. I. Section

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